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DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

MINERAL RESOURCES

OF THE

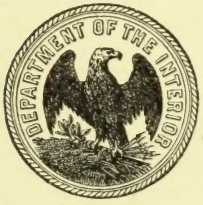
UNITED STATES

1914

H. D. McCASKEY
Geologist in Charge, Division of Mineral Resources

PART I—METALS

H. D. McCASKEY, Geologist in Charge



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MINERAL RESOURCES OF THE UNITED STATES FOR 1914—PART I.

MINERAL PRODUCTION OF THE UNITED STATES IN 1914.

By H. D. McCaskey.

INTRODUCTION.

The report on the mineral resources of the United States in 1914, from which the present compilation on mineral production is prepared, concludes the thirty-third year—nearly a third of a century—of the published reports of the mineral resources division of the United States Geological Survey. The work of the division has therefore been almost coexistent with that of the Survey itself.

For details of the various domestic mineral industries in 1914 the reader should consult the various chapters by subjects. These are gathered together in the two parts of the final report—Part I including the metallic subjects and Part II the nonmetallic. The individual chapters have been published in separate form, many of them long in advance of the volume, and the essential statistics have most of them been given out to the press before the separates were ready for distribution. In fact, preliminary reviews and close estimates of production, imports, and exports, and other statistical data for 1914 were given to the press within a few days after the close of the year. The volume therefore represents the final repository of the information for the year in review, but does not at all indicate the dates upon which the leading features of the component parts have been made available for use.

ACKNOWLEDGMENTS.

The United States Geological Survey is under obligation for reports from practically all mineral producers, smelters, refiners, mill men, and manufacturers of mineral products in the United States and Alaska, and to a very large degree also from all operators of prospects, mines, quarries, and wells not producing but undergoing some development, or being merely held by assessment work in 1914. The total number of operators to whom inquiries have been sent and concerning whose operations data have been obtained was somewhat over 92,000. Thankful acknowledgment is also here given to the considerable number of Federal and State officials, and to bankers, merchants, transportation officials, and others, who have generously responded to requests for data desired.

The compilation of the figures of production of this chapter and of the accompanying chart (in pocket) and the section "Review by products," from the reports elsewhere in Mineral Resources, have been contributed by Miss Martha B. Clark, statistical clerk. Her painstaking care and critical ability result in statistics of the highest accuracy. For many years the summary and the tabular statement were prepared for these volumes by Dr. Wm. T. Thom, and credit is due him for the valuable results of his work. The review by products continues the series of summaries by Dr. Thom and his predecessors. The statistics of imports and exports were compiled by Mr. J. A. Dorsey, of the Survey, from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

ORGANIZATION.

The division of mineral resources of the United States Geological Survey, which is responsible for the annual reports "Mineral Resources of the United States," is divided into two sections, the "metals section," which prepares the reports of Part I, and the "nonmetals section," which prepares those of Part II, including fuels, structural materials (other than metal), chemical minerals, and other nonmetallic products.

From 1907 to July 1, 1915, Mr. Edward W. Parker has been statistician in charge of the division and of the nonmetals section, as well as author of the reports on coal, coke, fuel briquetting, and the reviews of conditions of the mineral industry. For the last 25 years he has written the coal reports of Mineral Resources. His resignation from the Survey on July 1, 1915, to accept an important position with the anthracite interests, removed a recognized authority upon the subjects in which he specialized, an enthusiastic worker, and an executive whose long association with the division of mineral resources had won the affection as well as the loyal cooperation of all his associates and assistants.

During the last three years the metal section and, since July 1, 1915, the entire division of mineral resources have been under the supervision of the writer as geologist in charge.

Upon Mr. Parker's resignation Mr. Ernest F. Burchard was appointed geologist in charge of the nonmetals section.

For the purpose, primarily, of facilitating the collection of data on the precious and base metals of the Western States and also to provide local bureaus of information, the United States Geological Survey maintains offices at Denver, Colo., Salt Lake City, Utah, and San Francisco, Cal., and these offices have also been under the supervision of the writer for several years.

The division of mineral resources works in close cooperation with the division of geology, and most of the reports on mineral resources are now prepared by geologists working in both divisions, who have specialized in the subjects treated by them. The advantage of the services of these specialists, familiar with the occurrence, treatment, and uses of the mineral substances, is well recognized and has broadened the scope and usefulness of the reports.

The following authors have prepared the reports indicated for 1914:

General:

H. D. McCaskey—Mineral production of the United States in 1914. (A summary.)

Metals:

H. D. McCaskey—General report on gold and silver; quicksilver.
Alfred H. Brooks—Gold, silver, copper, lead, and zinc in Alaska (mines report).
Ernest F. Burchard—Iron ore, pig iron, and steel.
B. S. Butler—General report on copper; silver and copper in Michigan (mines report).
J. S. Diller—Chromic iron ore.
John P. Dunlop—Silver, copper, lead, and zinc in Central States, except Michigan (mines report); gold, silver, copper, lead, and zinc in Eastern States (mines report); metals and ores (a summary); statistics of secondary metals.
Clarence N. Gerry—Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
Frank L. Hess—Tin; arsenic; antimony; bismuth; selenium; tellurium; tungsten; vanadium; uranium; radium; nickel; cobalt; titanium; tantalum; molybdenum.
Victor C. Heikes—Gold, silver, copper, lead, and zinc in Arizona, Utah, Nevada, and Montana (mines reports).
Charles W. Henderson—Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Wyoming, and Texas (mines reports).
D. F. Hewett—Manganese and manganiferous ores.
James M. Hill—Platinum.
W. C. Phalen—Bauxite and aluminum.
C. E. Siebenthal—General reports on lead, zinc, and cadmium.
Charles G. Yale—Gold, silver, copper, lead, and zinc in California and Oregon (mines reports).

Nonmetals:

Edward W. Parker—Fuel briquetting.
Ernest F. Burchard—Fluorspar and cryolite; cement.
E. S. Bastin—Graphite.
A. T. Coons—Slate.
Charles A. Davis (U. S. Bureau of Mines)—Peat.
J. S. Diller—Asbestos; talc and soapstone.
R. B. Dole—Mineral waters, with historical sketch.
H. S. Gale (with Charles G. Yale)—Borax; magnesite.
James M. Hill—Mineral paints; barytes and strontium.
Frank J. Katz—Abrasive materials; silica (quartz); feldspar.
C. E. Lesher—Coke; coal.
G. F. Loughlin—Gypsum; sand and gravel; lime; stone.
Jefferson Middleton—Clay-working industries; sand-lime brick; fuller's earth.
J. D. Northrop—Asphalt, related bitumens, and bituminous rock; petroleum; natural gas.
W. C. Phalen—Phosphate rock; salt and bromine; potash salts; sulphur, pyrite, and sulphuric acid.
Douglas B. Sterrett—Gems and precious stones; mica.
Charles G. Yale (with H. S. Gale)—Borax; magnesite.

The writer repeats the high appreciation expressed by Mr. Parker in the report for 1913 of the hearty support and cordial cooperation given by his colleagues in the preparation of the reports, and of the efficient, loyal, and conscientious service rendered by the clerical and stenographic assistants. In many cases the statistical clerks have been connected with the collection and tabulation of assigned statistics for so long that they are identified with the subjects involved; and their high degree of skill, their careful scrutiny and criticism of the returns, and their conscientious devotion to duty have gone far to raise the standard of accuracy and completeness of the reports.

COOPERATION WITH STATE GEOLOGICAL SURVEYS.

In the collection of many of the data for the reports on mineral resources since 1910 the United States Geological Survey has had the cooperation of most of the State geological surveys. The sta-

tistics so obtained have been used jointly by the State and Federal surveys, and the results have been checked before publication. The objects aimed at in cooperation are mainly the avoidance of duplication of work and of divergent sets of figures bearing an official stamp.

Special acknowledgement is made to the following State officials for their cooperation in the statistical campaign for 1914:

Alabama	Dr. Eugene A. Smith, State geologist, University.
Florida	Dr. E. H. Sellards, State geologist, Tallahassee.
Illinois	Mr. Frank W. DeWolf, director, Urbana.
Iowa	Prof. George F. Kay, director, Iowa City.
Maryland	Dr. William B. Clark, State geologist, Baltimore.
Michigan	Mr. R. C. Allen, director, Lansing.
Minnesota	Dr. W. H. Emmons, director, Minneapolis.
Missouri	Dr. H. A. Buehler, director, Rolla.
New Jersey	Dr. Henry B. Kümmel, State geologist, Trenton.
New Mexico	Dr. Charles T. Kirk, State geologist, Albuquerque.
North Carolina	Dr. Joseph Hyde Pratt, State geologist, Chapel Hill.
Oregon	Prof. H. M. Parks, director, Corvallis.
Pennsylvania	Mr. Richard R. Hice, State geologist, Beaver.
Virginia	Dr. Thomas L. Watson, director, Charlottesville.
Washington	Prof. Henry Landes, State geologist, Seattle.
Wisconsin	Mr. W. O. Hotchkiss, State geologist, Madison.

RAW AND DERIVED PRODUCTS.

In compiling the statistics of mineral production the value of the metallic products is fixed upon the refined or partly refined metals, and is, of course, much greater than the value of the ores from which those products are obtained. During recent years the statistics of pig-iron production have been supplemented by accurate determinations of the quantity of iron ore produced and the value thereof, but the quantity and value of the pig iron have been maintained as the units of output. The ores of the precious and semiprecious metals are commonly complex mixtures of several metals, and no quantities or values can be expressed until the contents are extracted in metallic form and become articles of commerce. Chromic iron ore, manganese ore, manganiferous ores, and bauxite (aluminum ore), are marketed as such. In the nonmetals the quantities are expressed and the value placed upon the products in the condition in which they are first sold. With the fuels, with phosphate rock, and with some of the other nonmetals the quantities and values represent the raw product. With cement, however, there is no commercial product until the material is in the finished state as cement. The clay products appear as finished brick, terra cotta, tile, porcelain, and pottery, with the exception of a small quantity of special clays sold raw. The quarry products are sold rough, partly dressed, and finished; salt appears in various refined conditions, as the content of brine and as rock salt; gypsum is sold at first hand, as crude, as ground, and as calcined. There is no uniformity and there is no way of arriving at the quantities and values of the quarry products except in the condition as first marketed. The desirability of continuing to base the figures of iron production on the output and value of pig iron may be open to some question, particularly as accurate records of the production of ore and of the sources from which it is obtained are now available. In addition to putting a factitious value on the output, the distribution of the production of pig iron by

States gives undue prominence to the States in which the blast furnaces are located and deprives the ore-producing States of proper credit.

HISTORICAL REVIEW.

In the present report, as in the preceding reports of the series, the mineral production is treated primarily by subjects. For detailed discussion of the occurrence and production of each mineral substance by States the reader should consult the chapters by subjects in the two parts of this report. The statistics of production include comparisons with earlier years, the figures for which are carried forward each year for convenient reference. The earlier volumes, beginning with that of 1882, the first of the series, should be consulted for other notes on occurrence, development, trade conditions, and uses, descriptions of mining districts, and other information of a technical character which it is impracticable to carry forward from year to year. In the 33 years from 1882 to 1914, inclusive, the value of the mineral products of the country has increased from $451,901,159 to $2,114,946,024, or nearly five times. The value in 1913 was about five and a half times that in 1882. In 1880, according to the Tenth Census, the population of the United States numbered 50,189,209 persons, and the value of the mineral products reported by the same authority was $364,928,298, so that the value of the average production per inhabitant amounted to $7.27. At the taking of the Thirteenth Census in 1910 the population of the country had increased to 91,972,266 persons, a gain of about 80 per cent. The value of the mineral production in 1910 was $1,991,216,220, indicating an increase in the 30 years of $1,626,287,922, or nearly 450 per cent. The average output per inhabitant in 1910 was $21.65. The Bureau of the Census estimates the population of the United States, including Alaska, in 1914, on July 1, at 98,846,004 persons, and as the value of the mineral production in that year was $2,114,946,024, the average output per person as represented by value was $21.40. From 1880 to 1914 the population of the United States has increased a little less than 100 per cent, while the value of the mineral production has increased nearly sixfold. The per capita mineral production in 1914, as expressed in the value of the output was nearly three times that of 1880.

Notable increase in the last 35 years has been made in the value of the production of iron, gold, copper, lead, zinc, and aluminum, among the metals, and of fuels (coal, petroleum, and natural gas), cement, phosphate rock, mineral waters, mineral paints, sulphuric acid, sulphur, borax, gypsum, and clay products, among other nonmetallic products. In the case of silver the output of 1914 was more than double that of 1880, but the price was so much lower in 1914 that the value of the product was little more than that of 1880. In the case of quicksilver the production was only 16,548 flasks, valued at $811,680, in 1914, against 59,926 flasks, valued at $1,857,706, in 1880.

The following table shows rather strikingly the values of some of the productions mentioned above and the ratios of the two years compared:

Value and ratio of value of certain mineral products in 1880 and 1914.

Product.	1880	1914	Ratio.
Iron	$89,315,569	$298,777,429	1: 3.3
Gold	36,000,000	94,531,800	1: 2.6
Silver	34,717,000	40,067,700	1: 1.2
Copper	11,491,200	152,968,246	1: 13.3
Lead	9,782,500	39,997,932	1: 4.1
Zinc	2,277,432	35,028,636	1: 15.4
Coal[a]	95,640,396	681,490,643	1: 7.1
Petroleum	24,600,638	214,125,215	1: 8.7
Salt	4,829,566	10,271,358	1: 2.1
Cement	1,852,707	80,533,203	1: 43.5
Phosphate rock	1,123,823	9,608,041	1: 8.5
Natural gas[b]	215,000	94,115,524	1:437.7

[a] Including bituminous, anthracite, and other coal.
[b] None reported in 1880 and 1881. Value reported at $215,000 in 1882.

If it be considered that the population of the country has doubled in the last 35 years, we note that the value of the per capita supply of silver has decreased, that of salt remains about as it was 35 years ago, and there has been no great increase in the value of the per capita supply of gold. But the per capita value of iron is materially greater, that of lead is doubled, that of copper is nearly sevenfold, and that of zinc nearly eightfold; petroleum and phosphate rock are more than quadrupled and coal nearly fourfold, and the per capita supply of cement is nearly twenty-two times as much in value as in 1880, and natural gas nearly two hundred and nineteen times as much as in 1882.

The production of pig iron was 3,835,191 long tons in 1880 and increased to 22,263,263 tons in 1914. Both quantity and value in 1914, however, were considerably below those of several preceding years. In 1913 the figures reached the high-water mark of 30,388,935 long tons, valued at $458,342,345, or a value greater than that of the total mineral output of the country for each of the earlier years from 1880 to 1886, inclusive. The iron industry dates back to early Colonial days and an output of over a million tons of pig iron was reached as early as 1864. The great ore field of the Marquette range has also a long and impressive record antedating this series of reports.

The production of gold in 1914 was 4,572,976 fine ounces, valued at $94,531,800, against a production of only 1,741,500 ounces, valued at $36,000,000 in 1880. As in the case of iron larger outputs of gold were recorded in years preceding 1914. For instance, the production was valued at $94,560,000 in 1908 and reached its high level of $99,673,400 in 1909, declining to $96,269,100 in 1910, and increasing to $96,890,000 in 1911. The output of 1914, however, was greater than for any other year, except the few years mentioned above. The great Alaskan output has been a large factor in the increase of gold, as has the development, since 1880, of such new districts as Cripple Creek and Goldfield. The production now is probably at the full rate of the known workable resources, and it does not seem probable, from present data, that the total gold output of the United States and Alaska will exceed $100,000,000 a year at best. As new deposits are developed old ones are worked out, and, although improvements in treatment may render profitable further extraction of gold, this may not offset exhaustion of placers and other deposits whose limits are necessarily being reached.

The production of silver has more than doubled in quantity since 1880, increasing from 30,318,700 fine ounces in that year to 72,455,100 ounces (the record output) in 1914, but the increase in value, owing to fall in price, has only been from $34,717,000 in 1880 to $40,067,700 in 1914. The great output of silver from silver-gold ores of Tonopah and elsewhere and from the vast increase in copper and lead mining and smelting of recent years has much more than offset the decline of such conspicuous producers of the earlier days as the Comstock, Eureka, and other camps; but the lower-price levels as the metal has taken its natural place in the world's market, without artificial stimulation, have prevented corresponding rise in value.

The recorded production of copper dating from 1845 with an output of 224,000 pounds, steadily increased to 60,480,000 pounds in 1880 and to the great output of 1,243,268,720 pounds, valued at $205,139,338 in 1912, since when, owing to economic conditions, it has declined to 1,150,137,192 pounds, valued at $152,968,246 in 1914. All indications point to return to maximum output in 1915. In addition to the continued output from the great Lake and Butte mines, the domestic production has been remarkable in recent years from the great disseminated deposits of Arizona, Utah, Nevada, and New Mexico, where applied geologic knowledge and new mining and milling methods have contributed notably to the supremacy of the United States in copper output.

The production of lead, begun in a small way in the Central States in 1825 and amounting to only 17,830 short tons in 1870 and to 97,825 tons from all classes of domestic ores in 1880, broke all records with a total yield of 512,794 tons, valued at $39,997,932, in 1914. The soft-lead deposits of Missouri and the silver-lead deposits of Idaho and Utah have chiefly contributed to the increase in output in 1914.

The domestic production of zinc began in an experimental way in 1858 and began regularly in 1860 in both the Eastern and the Central States. In 1873 the output was 7,343 short tons and it increased to 23,239 tons in 1880, but the record production was in 1914, when it became 343,418 short tons, valued at $35,028,636. To the output of the New Jersey mines has been added the newly developed and important mines of eastern Tennessee; in the Central States Missouri continues supreme; and in the Western States developments at Butte, Mont., and at Leadville, Colo., have been especially noteworthy in recent years.

Foremost in both value and quantity, not only among nonmetallic minerals but among all mineral resources, we find coal. Domestic mining began in Virginia, Ohio, and Pennsylvania as far back as the Revolutionary War, and the early records show that from 1807 to 1820 about 12,000 short tons of Pennsylvania anthracite were mined and about 3,000 short tons of bituminous coal. In 1880 there were 28,649,812 short tons of anthracite and 42,831,758 short tons of bituminous coal produced, and in 1914 the production had increased to 81,090,631 long tons of anthracite, valued at $188,181,399, and 422,703,970 short tons of bituminous coal, valued at $493,309,244. The record output, however, was mined in 1913—81,718,680 long tons of anthracite, valued at $195,181,127, and 478,435,297

short tons of bituminous coal, valued at $565,234,952. Notwithstanding the current enormous extraction, supplies of domestic coal have been assured the nation's use for an indefinite time to come.

The needs of the country in fuel were first supplied from the forests and next from the coal mines. By 1859, however, petroleum was produced in Pennsylvania and New York, and the output reached 500,000 barrels, valued at $4,800,000, in 1860. By 1880 production had steadily increased to 26,286,123 barrels, valued at $24,600,638, contributed by Pennsylvania, New York, Ohio, West Virginia, and California; and in 1914 the record output of 265,762,535 barrels, valued at $214,125,215, was produced, with declining yield from some of the older producing fields but with large contributions from California, and also from Oklahoma, Illinois, Texas, Louisiana, and other States not productive in 1880.

The production of salt, which was among the half-dozen most important nonmetallic resources in 1880, increased from 5,961,060 barrels, valued at $4,829,566, in that year to 34,804,683 barrels, valued at $10,271,358, in 1914—a relatively small increase in value.

Natural gas also has supplemented earlier fuels, and from the first output, valued at $215,000 in 1882, it has reached the record output of $94,115,524 in 1914. The bulk of the output has been from Pennsylvania, but since 1909 West Virginia has been in the lead and for the last three years has had over double the output of Pennsylvania.

Cement has climbed rapidly from an output of 2,072,943 barrels, valued at $1,852,707, in 1880 to 87,257,552 barrels, valued at $80,533,203, in 1914, a decline from the record production of 89,541,348 barrels, valued at $89,550,527, in 1913. In the earlier years the production was chiefly of natural cement, as the output of Portland cement was only 42,000 barrels, valued at $126,000, in 1880. The natural-cement industry was at its highest in 1899; the output was equaled by that of Portland cement in 1900, since which time natural cement has declined and Portland cement has increased so rapidly that it now constitutes practically the whole of the vast output of cement. The Lehigh district of eastern Pennsylvania and western New Jersey has been predominant, but the cement industry is now actively pursued in many States. It has developed a high technique in correspondence with its rapid progress.

The output of phosphate rock has grown from 211,377 long tons, valued at $1,123,823, in 1880 to 2,734,043 tons, valued at $9,608,041, in 1914; and far surpassing in importance the extraction for use has been the discovery in the West of vast fields for future exploitation.

Among other remarkable developments of nonmetallic resources since 1880 may be mentioned those of stone, clay products, lime, and sand and gravel, all of which are in almost universal use and are represented by industries employing large numbers of operatives and producing millions in value.

REVIEW BY PRODUCTS.

GENERAL REMARKS.

The different units of measurement necessarily employed in the mineral industry make it impossible to combine and compare the output of the various minerals except in value.

In 1905, for the first time, the total value of the mineral production in the United States exceeded $1,500,000,000; in 1907 and again in 1912, 1913, and 1914 it exceeded $2,000,000,000. In 1908 the results of the financial depression of the latter part of 1907 became apparent in the decrease in value of the mineral output, which declined for the year to about $1,595,000,000. In 1909 the general recovery in business carried the value of mineral production up to nearly $1,887,000,000. In 1910 the continued favorable business conditions raised the value to more than $1,991,000,000—almost to the high level of 1907. In 1911 there was a sharp decline in pig iron that brought the total value for the year down to about $1,926,000,000, but the general swing of business in 1912 carried the value of mineral production above $2,244,000,000, thus advancing $318,000,000 beyond the preceding year. In 1913 the maximum production was recorded, the total being more than $2,439,000,000, an increase of $195,000,000 over 1912. In 1914 the value of the mineral production of the United States declined to $2,114,946,024, a decrease of about $324,000,000, or 13 per cent, from the record value for 1913—$2,439,159,728.

As heretofore, iron and coal are the most valuable of our mineral products. The value of the iron (pig iron being the basis of valuation) in 1914 was $298,777,429, and that of coal was $681,490,643. The fuels—coal, natural gas, and petroleum—decreased from $1,085,384,144 in 1913 to $989,731,382 in 1914, a loss of about $96,000,000, or 9 per cent.

The value of the metallic products decreased about $192,000,000, or 22 per cent, from $883,222,012 in 1913 to $691,000,343 in 1914, and the nonmetallic products, valued in 1913 at $1,555,517,716, fell to $1,423,395,681 in 1914, a decrease of about $132,000,000, or 8 per cent. The unspecified products (metallic and nonmetallic), valued in 1914 at $550,000, and including the value of bismuth, cadmium, ilmenite, lithium, marls, molybdenum, and selenium, and an estimate of the value of miscellaneous mineral products not collected annually by the Survey, bring the total value of the mineral production for 1914 up to $2,114,946,024.

The imports cited in this summary are imports "for consumption" (whenever such figures are available) for the calendar year, and may or may not be identical with "general" imports. Merchandise brought into the country late in December, for example, may be entered for consumption or it may be put into a warehouse and not withdrawn for consumption until the following calendar year. It is then credited "for consumption" to the year of its withdrawal from the warehouse.

The chart showing the mineral products of the United States from 1905 to 1914, by minerals, and since 1880, by metallic and nonmetallic totals, will be found in the pocket. There has been complete rearrangement of minerals alphabetically under the headings metallic and nonmetallic, which it is believed will render the data more convenient for reference. There has also been slight revision of some of the figures for years since 1905. Similar rearrangement and revision will be made for years prior to 1905 in the volume for 1915.

METALLIC PRODUCTS.

Aluminum.—The consumption of aluminum during 1914 was 79,129,000 pounds, valued at $14,522,700, against 72,379,000 pounds, valued at $13,845,000, in 1913; 65,607,000 pounds, valued at $11,907,000, in 1912; 46,125,000 pounds, valued at $8,084,000, in 1911; and 47,734,000 pounds, valued at $8,955,700, in 1910. The imports of aluminum salts for consumption were valued at $73,028 in 1914, $66,549 in 1913, and $84,606 in 1912. The exports of aluminum and of the manufactures of aluminum of domestic production were valued at $1,546,510 in 1914, $966,094 in 1913, $1,347,621 in 1912, $1,158,603 in 1911, and $945,215 in 1910.

Antimonial lead.—The production of antimonial lead in 1914 was 16,667 short tons, valued at $1,572,167, against 16,665 tons, valued at $1,591,854, in 1913; 13,552 tons, valued at $1,311,348, in 1912; 14,078 tons, valued at $1,380,556, in 1911; and 14,069 tons, valued at $1,338,090, in 1910.

Antimony.—The antimony contained in antimonial lead and that saved as a by-product in the process of refining copper, amounted in 1914 to 2,705 short tons, valued at $576,501, compared with 2,508 tons, $429,363, in 1913; 1,949 tons, $332,889, in 1912; and 2,254 tons, $386,786, in 1911. The imports of antimony (metal, regulus, and ore) for consumption were valued at $811,765 in 1914, $936,361 in 1913, $859,917 in 1912, $531,011 in 1911, and $539,755 in 1910; imports of oxide and salts of antimony were valued at $315,001 in 1914, $117,169 in 1913, and $81,077 in 1912.

Bauxite.—In 1914 the production of bauxite was 219,318 long tons, valued at $1,069,194, compared with 210,241 long tons, valued at $997,698, in 1913; 159,865 long tons, valued at $768,932, in 1912; 155,618 long tons, valued at $750,649, in 1911; and 148,932 long tons, valued at $716,258, in 1910. The imports for consumption were 24,844 long tons, valued at $96,500, in 1914, against 21,456 long tons, valued at $85,746, in 1913; 26,214 long tons, valued at $95,431, in 1912; 43,222 long tons, valued at $164,301, in 1911; and 15,669 long tons, valued at $65,743, in 1910.

Bismuth.—A production of bismuth (saved as a by-product in electrolytic refining of lead) was reported for 1914, amounting to 220,000 pounds, valued at $426,000, compared with 157,300 pounds, valued at $273,650, in 1913. The imports for consumption were valued at $165,208 in 1914, $213,257 in 1913, and $316,440 in 1912.

Cadmium.—Cadmium was produced in 1914 as in previous years, but the statistics may not be published, as individual figures would in this way be disclosed. The imports for consumption were valued at $368 in 1914, $1,232 in 1913, and $3,764 in 1912.

Chromic iron ore.—The marketed production of chromic iron ore in 1914 was 591 long tons, valued at $8,715, compared with 255 long tons, valued at $2,854, in 1913; 201 long tons, valued at $2,753, in 1912; 120 long tons, valued at $1,629, in 1911; and 205 long tons, valued at $2,729, in 1910. The imports of chromic iron ore for consumption were 80,736 long tons, valued at $695,645, in 1914, against 65,180 long tons, valued at $622,821, in 1913; 53,929 long tons, valued at $499,818, in 1912; 37,540 long tons, valued at $407,958, in 1911; and 38,579 long tons, valued at $415,768, in 1910. The

imports of chromic acid and chromates of potash were valued at $3,972 in 1914, $2,919 in 1913, and $4,461 in 1912.

Copper.—The production of copper in 1914 from domestic ores was 1,150,137,192 pounds, valued at $152,968,246, against 1,224,484,098 pounds, valued at $189,795,035, in 1913; 1,243,268,720 pounds, valued at $205,139,338, in 1912; 1,097,232,749 pounds, valued at $137,154,092, in 1911; and 1,080,159,509 pounds, valued at $137,180,257, in 1910. The decrease in 1914 was 74,346,906 pounds, or $36,826,789. The imports for consumption were valued at $39,491,973 in 1914, against $57,639,490, in 1913; and the exports in 1914 at $117,633,145, against $146,327,621 in 1913.

Ferro-alloys.—In the iron report for 1911 the United States Geological Survey undertook for the first time to present the statistics of production of ferro-alloys separately from those of pig iron, with which they had been included. As reported, the marketed production of ferro-alloys in 1914 was 255,524 long tons, valued at $9,350,245, compared with 296,207 long tons, valued at $13,015,362, in 1913; 328,685 long tons, valued at $12,223,776, in 1912; and 253,375 long tons, valued at $8,377,832, in 1911. Part of the output is derived from foreign ores. These quantities do not represent the total production of the United States, as considerable tonnages of electrically produced ferro-alloys have not been reported to the Survey. The Bureau of Foreign and Domestic Commerce reports the following values of imports of ferro-alloys for consumption in 1913 and 1914: Chrome and ferrochrome, $51,415 in 1913 and $21,553 in 1914; ferrophosphorus, none imported in 1913 and $1,136 in 1914; ferrosilicon, $449,871 and $341,925; ferromanganese, $5,682,915 and $3,619,607; molybdenum and ferromolybdenum, $15,939 and $59; spiegeleisen, $2,173 and $71,147; titanium and ferrotitanium, $7,198 and $8,356; tungsten and ferrotungsten, $835,212 and $222,447—a total of $7,044,723 in 1913 and $4,286,230 in 1914.

Gold.—The production of gold was 4,572,976 fine ounces, valued at $94,531,800, in 1914, compared with 4,299,784 fine ounces, valued at $88,884,400, in 1913; 4,520,717 fine ounces, valued at $93,451,500, in 1912; 4,687,053 fine ounces, valued at $96,890,000, in 1911; and 4,657,018 fine ounces, valued at $96,269,100, in 1910. The increase in 1914 was 273,192 fine ounces, valued at $5,647,400.

Iron (ore and pig).—The marketed production of iron ore in 1914 amounted to 39,714,280 long tons, valued at the mines at $71,905,079, compared with 59,643,098 long tons, valued at $130,905,558, in 1913; 57,017,614 long tons, valued at $107,050,153, in 1912; and 41,092,447 long tons, valued at $86,716,575, in 1911. The imports of iron ore for consumption were valued at $4,482,242 in 1914, and $8,332,777 in 1913; and the exports at $1,794,193 in 1914, $3,513,419 in 1913, $3,537,289 in 1912, and $2,653,448 in 1911.

The marketed production of pig iron in 1914 was 22,263,263 long tons, valued at $298,777,429, compared with 30,388,935 long tons, valued at $458,342,345, in 1913; 30,180,969 long tons, valued at $420,563,388, in 1912; and 23,257,288 long tons, valued at $327,334,624, in 1911. The marketed production in 1914 showed a decrease from 1913 of about 8,000,000 long tons, or 27 per cent, in quantity, and of about $160,000,000, or 35 per cent, in value. The average price of pig iron per long ton fell from $20.56 in 1907 to

$15.96 in 1908, rose to $16.25 in 1909, fell to $15.45 in 1910, to $14.07 in 1911, to $13.93 in 1912, rose to $15.08 in 1913, and fell to $13.42 in 1914. Prior to 1910, however, the values include ferro-alloys. The exports of pig iron in 1914 and 1913 were 114,423 long tons, valued at $1,638,102, and 277,648 tons, valued at $4,026,306, respectively.

Lead.—The production of refined lead from domestic ores in 1914 was 512,794 short tons, valued at $39,997,932, compared with 411,878 short tons, valued at $36,245,264, in 1913; 392,517 short tons, valued at $35,326,530, in 1912; 391,995 short tons, valued at $35,279,550, in 1911; and 375,402 short tons, valued at $33,035,376, in 1910. The imports of lead for consumption were valued at $504,978 in 1914, against $572,980 in 1913, $605,551 in 1912, $631,654 in 1911, and $755,092 in 1910; and the exports of lead at $5,519,908 in 1914 and $738,135 in 1913.

Manganese ore.—The marketed production of manganese ore in 1914 was 2,635 long tons, valued at $27,377, compared with 4,048 long tons, valued at $40,480, in 1913; 1,664 long tons, valued at $15,723, in 1912; 2,457 long tons, valued at $24,586, in 1911; and 2,258 long tons, valued at $22,892, in 1910. The average price per ton at the mine was $9.45 in 1912, $10 in 1913, and $10.39 in 1914. The imports of manganese ore for consumption were 283,294 long tons, valued at $2,024,120, in 1914, against 345,090 long tons, valued at $2,029,680, in 1913; and 300,661 long tons, valued at $1,769,184, in 1912.

Manganiferous ore.—The marketed production of manganiferous ore (exclusive of those Lake Superior ores running so low in manganese as to be classed with iron ore) was 98,265 long tons, valued at $218,497, against 59,403 long tons, valued at $25,124, in 1913; 51,517 long tons, valued at $19,942, in 1912; and 44,437 long tons, valued at $114,918, in 1911.

Molybdenum.—A small production of molybdenum was reported for 1914, but none is known to have been produced in 1913. Imports of molybdenum and ferromolybdenum were valued at $59 in 1914, $15,939 in 1913, $4,670 in 1912, $11,409 in 1911, and $14,402 in 1910.

Nickel.—Metallic nickel and nickel in salts and speiss, amounting to 845,334 pounds, valued at $313,000, was saved as a by-product in electrolytic refining of copper in 1914, compared with 481,565 pounds, valued at $79,393, in 1913. The imports of nickel for consumption were valued at $5,028,818 in 1914, against $6,600,755 in 1913, $5,758,967 in 1912, $4,050,030 in 1911, and $4,227,838 in 1910. The exports were valued at $9,455,528 in 1914, $9,686,794 in 1913, $8,515,332 in 1912, $8,283,777 in 1911, and $4,704,088 in 1910.

Platinum and allied metals.—The production of refined platinum and allied metals in 1914 was 6,324 ounces, valued at $280,885, as compared with 1,034 ounces, valued at $46,530, in 1913; 1,005 ounces, valued at $45,778, in 1912; 940 ounces, valued at $40,890, in 1911; and 773 ounces, valued at $25,277, in 1910. The imports of platinum (manufactured and unmanufactured) for consumption were valued at $2,908,353 in 1914, $5,040,210 in 1913, $4,503,682 in 1912, $4,866,207 in 1911, and $3,654,664 in 1910. In 1914 the imports of the platinum-group metals (other than platinum) for consumption were: Iridium, $112,430; osmiridium, $84,363; osmium,

none; palladium, $69,547; rhodium, $1,905; and ruthenium, $576—a total of $268,821. In 1913 these imports were: Iridium, $295,864; osmiridium, $11,872; osmium, $42,924; palladium, $364,738; rhodium, $3,668; and ruthenium, none—a total of $719,066.

Quicksilver.—The production of quicksilver in 1914 amounted to 16,548 flasks, valued at $811,680, against 20,213 flasks, valued at $813,171, in 1913; 25,064 flasks, valued at $1,053,941, in 1912; 21,256 flasks, valued at $977,989, in 1911; and 20,601 flasks, valued at $958,153, in 1910. The imports for consumption were valued at $271,984 in 1914, $75,361 in 1913, $39,920 in 1912, and $251,386 in 1911; and the exports at $70,753 in 1914, $43,574 in 1913, $13,360 in 1912, $13,995 in 1911, and $91,077 in 1910.

Selenium.—The production of selenium in 1914, saved as a by-product in electrolytic refining of copper, was 22,867 pounds, valued at $34,277, compared with 29,097 pounds, valued at about $46,900, in 1913.

Silver.—The production of silver was 72,455,100 fine ounces, valued at $40,067,700 in 1914, against 66,801,500 fine ounces, valued at $40,348,100, in 1913; 63,766,800 fine ounces, valued at $39,197,500, in 1912; 60,399,400 fine ounces, valued at $32,615,700, in 1911; and 57,137,900 fine ounces, valued at $30,854,500, in 1910. The increase in quantity in 1914 was 5,653,600 fine ounces, but the value decreased $280,400.

Tantalum minerals.—No production of tantalum minerals was reported for 1912, 1913, or 1914. Very small quantities of tantalum ore (columbite) were reported mined in 1911, 1910, and 1909, but none was reported marketed.

Tellurium.—A small quantity of tellurium was obtained from copper anode muds in 1913. The quantity saved in 1914 was inconsiderable.

Tin.—About 155 short tons of tin ore (equivalent to 104 tons of metallic tin), valued at $66,560, were reported for 1914, against 120 tons of 60 per cent ore in 1913, valued at $46,699, and 147 tons of 60 per cent ore in 1912, valued at $124,800. In 1911 the output of tin was valued at $56,635, and in 1910 at $23,447. The imports of tin for consumption were valued at $32,943,059 in 1914, $46,946,756 in 1913, $50,372,478 in 1912, $43,346,394 in 1911, and $33,913,255 in 1910.

Titanium minerals.—The Virginia mines reported 94 short tons of rutile, valued at $11,280, and 89 tons of ilmenite, valued at $4,895, in 1914, against 305 tons of rutile, valued at $49,000, in 1913; 275 tons of rutile, valued at $27,500, in 1912; no production in 1911; and 566 tons of rutile, valued at $44,480, in 1910. Imports of titanium and ferrotitanium were valued at $8,356 in 1914, $7,198 in 1913, $7,631 in 1912, $22,700 in 1911, and $767 in 1910.

Tungsten ore.—The production of tungsten ore (60 per cent concentrates) in 1914 was 990 short tons, valued at $435,000, against 1,537 tons, $672,118, in 1913; 1,330 tons, $502,158, in 1912; 1,139 tons, $407,985, in 1911; and 1,821 tons, $832,992, in 1910. The imports of tungsten ore for consumption were valued at $139,687 in 1914, and $213,122 in 1913. Tungsten and ferrotungsten were imported, valued at $222,447 in 1914, $835,212 in 1913, and $323,872 in 1912.

Uranium and vanadium minerals.—The production of uranium and vanadium minerals in 1914 was valued at $941,300, compared with a production in 1913, valued at $609,361. The 1914 production consisted of 4,294 tons of uranium ore (carnotite), valued at $441,300 (including the value of 22.3 grams of radium, not isolated), and 452 tons of vanadium in roscoelite and carnotite ores with an arbitrarily assigned value of $500,000. Imports of ferrovanadium, valued at $2,623, were reported for 1911; none were reported for 1912, 1913, and 1914. Imports of uranium salts and oxide, including some radium salts, were valued at $63,055 in 1914, and at $34,319 in 1913.

Zinc.—The production of zinc in 1914 was 343,418 short tons, valued at $35,028,636, against 337,252 tons, $37,772,224, in 1913; 323,907 tons, $44,699,166, in 1912; 271,621 tons, $30,964,794, in 1911; and 252,479 tons, $27,267,732, in 1910. The imports of zinc ore and manufacturers of zinc for consumption were valued at $425,205 in 1914, $1,079,994 in 1913, $2,114,435 in 1912, $435,329 in 1911, and $1,031,437 in 1910. The exports of domestic zinc ore and domestic manufactures of zinc were valued at $9,381,050 in 1914, $1,735,099 in 1913, $1,846,301 in 1912, $1,935,677 in 1911, and $1,558,271 in 1910.

Metals and ores.—The chapter on metals and ores was published for the first time for the year 1909. The output of metals in the United States in 1914 from domestic ores was valued at $679,045,753, from foreign sources at $116,658,488, the total being $795,704,241. In 1913, the corresponding figures were: Domestic, $855,351,064; foreign, $161,256,794; total, $1,016,607,858. The output of crude metallic ores of all kinds from domestic mines amounted to 134,215,858 short tons in 1913 and in 1914 to 113,579,697 short tons.

NONMETALLIC PRODUCTS.

Arsenious oxide.—The production of arsenious oxide (white arsenic) in 1914 amounted to 4,670 short tons, valued at $313,147, against 2,513 tons, valued at $159,236 in 1913; 3,141 tons, valued at $190,757, in 1912; and 3,132 tons, valued at $73,408, in 1911. The imports of "arsenic or arsenious acid" and "arsenic sulphide or orpiment" for consumption were valued at $273,713 in 1914, $410,446 in 1913, and $428,741 in 1912.

Asbestos.—The production of asbestos in 1914 was 1,247 short tons, valued at $18,965, against 1,100 short tons, valued at $11,000, in 1913; 4,403 short tons, valued at $87,959, in 1912; 7,604 short tons, valued at $119,935, in 1911; and 3,693 short tons, valued at $68,357, in 1910. The imports of asbestos (manufactured and unmanufactured) for consumption were valued at $1,779,223 in 1914, $2,307,666 in 1913, $1,819,771 in 1912, $1,703,639 in 1911, and $1,543,248 in 1910.

Asphalt.—Under the term "asphalt" are included the various bitumens or hydrocarbon minerals not discussed elsewhere under petroleum. The production in 1914 was 438,271 short tons, valued at $3,647,592, compared with 529,190 short tons, valued at $5,282,370, in 1913; 449,510 short tons, valued at $4,620,731, in 1912; 364,266 short tons, valued at $3,991,109, in 1911; and 260,080 short tons, valued at $3,080,067, in 1910. The imports of asphalt for consumption were valued at $675,618 in 1914, $910,611 in 1913, $921,145 in 1912, and $789,236 in 1911. The exports for the years 1914 and 1913 were valued at $1,247,020 and $1,679,411, respectively.

Barytes and strontium.—The production of crude barytes in 1914 was 51,547 short tons, valued at $153,715, compared with 45,298 short tons, valued at $156,275, in 1913; 37,478 short tons, valued at $153,313, in 1912; 38,445 short tons, valued at $122,792, in 1911; and 42,975 short tons, valued at $121,746, in 1910. The imports of barytes (manufactured and unmanufactured) for consumption were valued at $77,265 in 1914, $99,564 in 1913, and $79,315 in 1912. The imports of barium compounds were valued at $478,583 in 1914, $391,470 in 1913, and $376,017 in 1912. No strontium was reported as mined during 1914 or 1913. Imports of strontia oxide, protoxide of strontium, and strontianite were valued at $1,016 in 1914 and at $2,284 in 1913.

Borax.—The production of crude borax in 1914 was 62,400 short tons, valued at $1,464,400, against 58,051 short tons, valued at $1,491,530, in 1913; 42,315 short tons, valued at $1,127,813, in 1912; and 53,330 short tons, valued at $1,569,151, in 1911. The imports of borax and borates for consumption were valued at $19,412 in 1914, $18,534 in 1913, and $11,249 in 1912.

Bromine.—The production of bromine in 1914 amounted to 576,991 pounds, valued at $203,094, against 572,400 pounds, valued at $115,436, in 1913; 647,200 pounds, valued at $145,805, in 1912; 651,541 pounds, valued at $110,902, in 1911; and 245,437 pounds, valued at $31,684, in 1910.

Calcium chloride.—The production of calcium chloride in 1914 was 19,403 short tons, valued at $121,766, against 19,611 short tons, valued at $130,030, in 1913; 18,550 short tons, valued at $117,272, in 1912; 14,606 tons, valued at $91,215, in 1911; and 10,971 tons, valued at $74,713, in 1910.

Cement.—The total marketed production of the principal hydraulic cements in the United States in 1914 was 87,257,552 barrels, valued at $80,533,203, compared with 89,541,348 barrels, valued at $89,550,527, in 1913; and 85,925,651 barrels, valued at $69,554,385, in 1912. The marketed production of Portland cement in 1914 was 86,437,956 barrels, valued at $80,118,475, compared with 88,689,377 barrels, valued at $89,106,975, in 1913; and 85,012,556 barrels, valued at $69,109,800, in 1912. The marketed production of natural cement in 1914 was 751,285 barrels, valued at $351,370, compared with 744,658 barrels, valued at $345,889, in 1913; and 821,231 barrels, valued at $367,222, in 1912. The marketed production of puzzolan cement in 1914 amounted to 68,311 barrels, valued at $63,358, against 107,313 barrels, valued at $97,663, in 1913; and 91,864 barrels, valued at $77,363, in 1912. The imports of hydraulic cements for consumption were valued at $194,053 in 1914, $139,416 in 1913, and $93,558 in 1912; and the exports at $3,088,809 in 1914, $4,270,666 in 1913, and $6,160,341 in 1912.

Clay products and raw clay.—The value of all clay products in 1914 was $164,986,983, compared with $181,289,132 in 1913; $172,811,275 in 1912; $162,236,181 in 1911; and $170,115,974 in 1910. The imports of brick and tile, etc., for consumption were valued at $207,644 in 1914, against $276,677 in 1913, and $215,379 in 1912; and the exports at $3,051,103 in 1914, $4,228,908 in 1913, and $3,823,111 in 1912. The pottery products were valued at $35,398,161 in 1914, $37,992,375 in 1913, $36,504,164 in 1912, $34,518,560 in 1911, and

$33,784,678 in 1910. The imports of pottery for consumption amounted to $8,349,442 in 1914, against $10,177,451 in 1913, $9,555,530 in 1912, $10,638,616 in 1911, and $11,131,158 in 1910; and the exports of pottery were valued at $526,902 in 1914, $559,331 in 1913, and $1,177,784 in 1912.

Clay mined and sold as unmanufactured clay was valued at $3,756,568 in 1914, against $4,180,459 in 1913. The imports of kaolin or china clay for consumption were valued at $1,927,425 in 1914, $1,623,993 in 1913, and $1,629,105 in 1912. The imports of other clays for consumption amounted to $359,993 in 1914, against $382,782 in 1913.

Coal.—In 1906 the production of coal in the United States exceeded for the first time 400,000,000 short tons; in 1910, four years later, it exceeded half a billion tons, the figures being 501,596,378 short tons, valued at $629,557,021. The output fell to 496,371,126 short tons, valued at $626,565,211, in 1911, advancing to 534,466,580 tons, valued at $695,606,071, in 1912, and in 1913 to the maximum production, 569,960,219 tons, valued at $760,416,079. In 1914 the output declined to 513,525,477 tons, valued at $681,490,643.

The production of bituminous coal (which includes all coals except anthracite mined in Pennsylvania) amounted to 422,703,970 short tons, valued at $493,309,244, compared with 478,435,297 short tons, valued at $565,234,952, in 1913; 450,104,982 short tons, valued at $517,983,445, in 1912; 405,907,059 short tons, valued at $451,375,819, in 1911; and 417,111,142 short tons, valued at $469,281,719, in 1910. The decrease in the production of bituminous coal in 1914 was, therefore, about 56,000,000 short tons, or 12 per cent, in quantity, and about $72,000,000, or 13 per cent, in value. The average price per ton of bituminous coal at the mine was $1.17 in 1914, $1.18 in 1913, $1.15 in 1912, $1.11 in 1911, and $1.12 in 1910. The imports of bituminous coal for consumption were valued at $3,902,881 in 1914, $3,853,930 in 1913, $4,509,066 in 1912, and $3,604,797 in 1911. The exports were valued at $34,104,903 (not including bunker coal valued at $24,145,735) in 1914, and at $45,449,664 (not including bunker coal valued at $25,036,272) in 1913.

The output of Pennsylvania anthracite in 1914 was 81,090,631 long tons, valued at $188,181,399, compared with 81,718,680 long tons, valued at $195,181,127, in 1913; 75,322,855 long tons, valued at $177,622,626, in 1912; 80,771,488 long tons, valued at $175,189,392, in 1911; and 75,433,246 long tons, valued at $160,275,302, in 1910. The decrease in value in 1914 as compared with 1913 was about $7,000,000, or 4 per cent. The average price of Pennsylvania anthracite at the mine during the season of 1914 was $2.07 per long ton, against $2.13 in 1913, $2.11 in 1912, $1.94 in 1911, and $1.90 in 1910. The imports of anthracite for consumption were valued at $25,380 in 1914, $5,620 in 1913, and $8,329 in 1912; and the exports at $20,211,072 in 1914 and $21,959,850 in 1913.

Coal briquets.—The production of coal briquets in the United States in 1914 was 250,635 short tons, valued at $1,154,678, against 181,859 short tons, valued at $1,007,327, in 1913, and 220,064 short tons, valued at $952,261, in 1912.

Cobalt oxide.—No cobalt oxide has been produced in the United States from domestic ores since 1909. The imports of cobalt (oxide,

ore, and zaffer) for consumption were valued at $274,538 in 1914, $95,735 in 1913, $83,080 in 1912, $59,151 in 1911, and $6,352 in 1910.

Coke.—The production of coke in 1914 amounted to 34,555,914 short tons (11,219,943 tons from retort ovens), valued at $88,334,217, against 46,299,530 short tons (12,714,700 tons from retort ovens), valued at $128,922,273, in 1913; 43,983,599 short tons (11,115,164 tons from retort ovens), valued at $111,805,113, in 1912; 35,551,489 short tons (7,847,845 tons from retort ovens), valued at $84,130,849 in 1911; and 41,708,810 short tons (7,138,734 tons from retort ovens), valued at $99,742,701 in 1910. The average price of coke per ton was $2.56 in 1914, $2.78 in 1913, $2.54 in 1912, $2.37 in 1911, and $2.39 in 1910. The imports of coke for consumption were valued at $551,104 in 1914, $435,157 in 1913, and at $488,398 in 1912, and the exports at $2,233,686 in 1914, $3,309,930 in 1913, and $3,002,742 in 1912.

Diatomaceous (infusorial) earth and tripoli.—The value of the diatomaceous (infusorial) earth and tripoli produced in 1914 was $252,327, against $285,821 in 1913, $125,446 in 1912, $147,462 in 1911, and $130,006 in 1910. The imports of diatomaceous earth, rottenstone, and tripoli for consumption were valued at $20,004 in 1914, $28,696 in 1913, and $24,253 in 1912.

Emery and corundum.—No corundum has been produced since 1906. The output of emery in 1914 was 485 short tons, valued at $2,425, against 957 short tons, valued at $4,785, in 1913, and 992 short tons, valued at $6,652, in 1912. The imports of emery and corundum for consumption were valued at $383,436 in 1914, $474,299 in 1913, and $491,725 in 1912.

Feldspar.—The production of feldspar in 1914 was 135,419 short tons, valued at $629,873, compared with 120,955 short tons, valued at $776,551, in 1913; 86,572 short tons, valued at $520,562 in 1912; 92,700 short tons, valued at $579,008 in 1911; and 81,102 short tons, valued at $502,452, in 1910.

Fertilizers.—Fertilizers, including apatite, bone dust, guano, kainite, kieserite, crude phosphates, and other manures, are shown under phosphate rock and under potash salts, and sodium nitrate is mentioned as such.

Fluorspar and cryolite.—The production of fluorspar in 1914 was 95,116 short tons, valued at $570,041, compared with 115,580 short tons, valued at $736,286, in 1913; 116,545 short tons, valued at $769,163, in 1912; 87,048 short tons, valued at $611,447, in 1911; and 69,427 short tons, valued at $430,196, in 1910. The imports of fluorspar for consumption were 10,205 short tons, valued at $38,943, in 1914; 22,682 short tons, valued at $71,463, in 1913; and 26,176 short tons, valued at $71,616, in 1912

No cryolite is produced in the United States. The imports were valued at $94,424 in 1914 and at $52,557 in 1913.

Fuller's earth.—The production of fuller's earth in 1914 was 40,981 short tons, valued at $403,646, against 38,594 short tons, valued at $369,750, in 1913; 32,715 short tons, valued at $305,522, in 1912; 40,697 short tons, valued at $383,124, in 1911; and 32,822 short tons, valued at $293,709, in 1910. The imports of fuller's earth (manufactured and unmanufactured) for consumption were valued at $195,083 in 1914, $146,001 in 1913, and $145,337 in 1912.

Garnet.—The production of abrasive garnet in 1914 amounted to 4,231 short tons, valued at $145,510, against 5,308 short tons, valued at $183,422, in 1913; 4,947 short tons, valued at $163,237, in 1912; 4,076 short tons, valued at $121,748, in 1911; and 3,814 short tons, valued at $113,574, in 1910. No record is kept of imports of abrasive garnet.

Gems and precious stones.—The value of gems and precious stones found in the United States in 1914 was $124,651, against $319,454 in 1913, $319,722 in 1912, $343,692 in 1911, and $295,797 in 1910. Imports of precious stones (including pearls) for consumption were valued at $19,211,084 in 1914, against $45,431,998 in 1913, $41,363,325 in 1912, $40,820,436 in 1911, and $40,704,487 in 1910.

Graphite.—The production of amorphous graphite in 1914 was 1,725 short tons, valued at $38,750, compared with 2,243 short tons, valued at $39,428, in 1913; 2,063 short tons, valued at $32,894, in 1912; 1,223 short tons, valued at $32,415, in 1911; and 1,407 short tons, valued at $39,710, in 1910. The production of crystalline graphite during 1914 amounted to 5,220,539 pounds, valued at $285,368, compared with 5,064,727 pounds, valued at $254,328, in 1913; 3,543,771 pounds, valued at $187,689, in 1912; 4,790,000 pounds, valued at $256,050, in 1911; and 5,590,592 pounds, valued at $295,733, in 1910. The production of manufactured graphite in 1914 was 10,455,139 pounds, valued at $698,800, compared with 13,633,342 pounds, valued at $973,397, in 1913. The imports of graphite for consumption were valued at $1,398,209 in 1914 and at $2,109,791 in 1913.

Grindstones and pulpstones.—The value of all kinds of grindstones and pulpstones produced in 1914 was $689,344, against $855,627 in 1913, $916,339 in 1912, $907,316 in 1911, and $796,294 in 1910. The imports for consumption were valued at $109,539 in 1914, $139,386 in 1913, and $131,080 in 1912.

Gypsum.—The output of gypsum in 1914 was 2,476,465 short tons, valued at $6,895,989, compared with 2,599,508 short tons, valued at $6,774,822, in 1913; 2,500,757 short tons, valued at $6,563,908, in 1912; 2,323,970 short tons, valued at $6,462,035, in 1911; and 2,379,057 short tons, valued at $6,523,029, in 1910. The imports of gypsum for consumption were valued at $444,841 in 1914, $556,922 in 1913, $488,481 in 1912, and $450,806 in 1911.

Lime.—The production of lime in 1914 was 3,380,928 short tons, valued at $13,247,676, against 3,595,390 short tons, valued at $14,648,362, in 1913; 3,529,462 short tons, valued at $13,970,114, in 1912; 3,392,915 short tons, valued at $13,689,054, in 1911; and 3,505,954 short tons, valued at $14,088,039, in 1910. The imports of lime for consumption were 3,455 short tons, valued at $33,670 in 1914, against 4,139 short tons, valued at $48,538, in 1913; and the exports were valued at $170,744 in 1914, compared with $212,345 in 1913.

Lithium minerals.—A small production of lithium minerals was reported in 1914 as in previous years, but the statistics may not be published as doing so would disclose individual figures.

Magnesite.—The production of crude magnesite continues to be limited to California. During 1914 the production was 11,293 short tons, valued at $124,223, against 9,632 short tons, valued at $77,056,

in 1913; 10,512 short tons, valued at $84,096, in 1912; 9,375 short tons, valued at $75,000, in 1911; and 12,443 short tons, valued at $74,658, in 1910. The imports of magnesia and magnesite for consumption were valued at $1,453,508 in 1914, at $1,805,274 in 1913, and $1,430,542 in 1912.

Marls.—No considerable production of marls has been reported since 1908. There was a very small output in 1914 as in preceding years.

Mica.—The production of mica in 1914 consisted of 3,730 short tons of scrap mica, valued at $51,416, and 556,933 pounds of sheet mica, valued at $278,540, against 5,322 short tons of scrap, valued at $82,543, and 1,700,677 pounds of sheet, valued at $353,517, in 1913; 3,226 short tons of scrap, valued at $49,073, and 845,483 pounds of sheet, valued at $282,823, in 1912; 3,512 short tons of scrap, valued at $45,550, and 1,887,201 pounds of sheet, valued at $310,254, in 1911; and 4,065 short tons of scrap, valued at $53,265, and 2,476,190 pounds of sheet, valued at $283,832, in 1910. The imports of mica for consumption were valued at $625,396 in 1914, $943,018 in 1913, $748,973 in 1912, $502,163 in 1911, and $724,525 in 1910.

Millstones.—The value of the production of millstones in 1914 was $43,316, against $56,163 in 1913 and $71,414 in 1912. The imports of burrstones and millstones for consumption were valued at $15,000 in 1914, $40,198 in 1913, and $27,562 in 1912.

Mineral paints.—The marketed production of mineral paints (natural and zinc and lead pigments) in 1914 amounted to 173,557 short tons, valued at $10,451,746, against 168,168 short tons, valued at $9,533,306, in 1913; 181,154 short tons, valued at $10,069,588, in 1912; 143,350 short tons, valued at $7,842,583, in 1911; and 143,785 short tons, valued at $7,380,599, in 1910. Imports of ocher for consumption were valued at $141,704 in 1914, $143,720 in 1913, and $148,306 in 1912; of sienna, at $63,958 in 1914, $48,535 in 1913, and $45,794 in 1912; of umber, at $45,280 in 1914, $36,771 in 1913, and $31,626 in 1912; of zinc oxide, at $302,838 in 1914, $434,156 in 1913, and $386,153 in 1912.

Mineral waters.—The marketed production of mineral waters in 1914 was 54,358,466 gallons, valued at $4,892,328, compared with 57,867,399 gallons, valued at $5,631,391, in 1913; 62,281,201 gallons, valued at $6,615,671, in 1912; 63,788,552 gallons, valued at $6,837,888 in 1911; and 62,030,125 gallons, valued at $6,357,590, in 1910. The imports of mineral waters for consumption were valued at $857,707 in 1914, $955,788 in 1913, and $930,091 in 1912.

Natural gas and gasoline.—The value of natural gas produced in 1914 was $94,115,524, compared with $87,846,677 in 1913, $84,563,957 in 1912, $74,621,534 in 1911, and $70,756,158 in 1910. No imports of natural gas have been reported since 1909, when they were valued at $6,060, compared with $22,003 in 1908.

The production of gasoline extracted from casing-head gas (natural gas from oil wells) amounted to 42,652,632 gallons, valued at $3,105,909, in 1914, against 24,060,817 gallons, valued at $2,458,443, in 1913; 12,081,179 gallons, valued at $1,157,476, in 1912; and 7,425,839 gallons, valued at $531,704, in 1911. The imports of gasoline were valued at $587 in 1914 and at $1,661 in 1913, and the exports in 1914 and 1913 at $19,897,613 and $17,418,777, respectively.

Oilstones, etc.—The production of oilstones, etc., in 1914 was valued at $167,948, against $207,352 in 1913, $232,218 in 1912, $214,991 in 1911, and $228,694 in 1910. The imports for consumption were valued at $33,655 in 1914, $40,222 in 1913, and $45,398 in 1912.

Peat.—The production of peat in 1914 was valued at $309,692, against $197,200 in 1913, $228,572 in 1912, $272,114 in 1911, and $140,209 in 1910. The imports of peat for consumption were valued at $57,542 in 1914 and $55,719 in 1913.

Petroleum.—The marketed output of crude petroleum in 1914 was 265,762,535 barrels, valued at $214,125,215, against 248,446,230 barrels, valued at $237,121,388, in 1913; 222,935,044 barrels, valued at $164,213,247, in 1912; 220,449,391 barrels, valued at $134,044,752, in 1911; and 209,557,248 barrels, valued at $127,899,688, in 1910. The average price for crude petroleum per barrel in 1914 was 80.6 cents, 95.4 cents in 1913, 73.7 cents in 1912, 60.8 cents in 1911, and 61 cents in 1910. The imports of petroleum for consumption were valued at $11,464,879 in 1914, $12,945,619 in 1913, $6,082,881 in 1912, $2,410,884 in 1911, and $1,398,861 in 1910, and the exports of petroleum and its products (mineral oils) at $120,002,974 in 1914, against $131,897,632 in 1913, $124,210,382 in 1912, $105,922,848 in 1911, and $94,107,022 in 1910. The imports of ozokerite and paraffin (oil and wax) for consumption were valued at $860,929 in 1914, against $982,352 in 1913, $1,018,524 in 1912, $792,818 in 1911, and $1,025,829 in 1910. The exports of paraffin and paraffin wax were valued at $6,434,831 in 1914, and at $8,176,831 in 1913, $9,602,758 in 1912, $7,047,856 in 1911, and $7,329,143 in 1910.

Phosphate rock.—The marketed production of phosphate rock in 1914 amounted to 2,734,043 long tons, valued at $9,608,041, compared with 3,111,221 long tons, valued at $11,796,231, in 1913; 2,973,332 long tons, valued at $11,675,774, in 1912; 3,053,279 long tons, valued at $11,900,693, in 1911; and 2,654,988 long tons, valued at $10,917,000, in 1910. The quantity of phosphate rock reported as mined during 1914 was 2,649,174 long tons, against 3,152,208 long tons mined in 1913. The imports of crude phosphates, guano, kainite, manure salts, etc., for consumption were valued at $9,921,439 in 1914, $10,819,253 in 1913, and $8,893,090 in 1912. The exports of phosphate rock in 1914 were 964,114 long tons, valued at $6,771,652 against 1,366,508 long tons, valued at $9,996,580, in 1913; and 1,206,520 long tons, valued at $8,996,456, in 1912.

Potash salts.—There was no actual production of potash salts in the United States in 1914. The imports of potash salts (not including kainite and manure salts) for consumption were valued at $8,743,973 in 1914, against $10,805,720 in 1913.

Pumice.—The production of pumice amounted to 27,591 short tons, valued at $59,172, in 1914, against 24,563 short tons, valued at $55,408, in 1913; 27,146 short tons, valued at $86,687, in 1912; and 21,689 short tons, valued at $88,399, in 1911. The imports for consumption were valued at $92,668 in 1914, $93,408 in 1913, $74,478 in 1912, and $118,977 in 1911.

Pyrite.—The production of pyrite in 1914 was 336,662 long tons, valued at $1,283,346, against 341,338 long tons, valued at $1,286,084, in 1913; 350,928 long tons, valued at $1,334,259, in 1912; 301,458 long tons, valued at $1,164,871, in 1911; 241,612 long tons valued at

$977,978, in 1910. The imports of pyrite (containing not more than 3.5 per cent of copper) for consumption were valued at $4,797,326 in 1914, $3,611,137 in 1913, $3,841,683 in 1912, $3,788,803 in 1911, and $2,748,647 in 1910.

Salt.—The marketed production of salt in 1914 amounted to 34,804,683 barrels, valued at $10,271,358, compared with 34,399,298 barrels, valued at $10,123,139, in 1913; 33,324,808 barrels, valued at $9,402,772, in 1912; 31,183,968 barrels, valued at $8,345,692, in 1911; and 30,305,656 barrels, valued at $7,900,344, in 1910. The imports for consumption were valued at $380,803 in 1914, against $421,745 in 1913, and $370,648 in 1912, and the exports at $586,055 in 1914, $515,194 in 1913, and $418,525 in 1912.

Sand and gravel.—The production of glass sand in 1914 was 1,619,649 short tons, valued at $1,568,030, compared with 1,791,800 short tons, valued at $1,895,991, in 1913; 1,465,386 short tons, valued at $1,430,471, in 1912; 1,538,666 short tons, valued at $1,543,733, in 1911; and 1,461,089 short tons, valued at $1,516,711, in 1910. The production of gravel and of sand for molding, building, engine, furnace, and other uses (exclusive of glass sand) was 77,662,086 short tons, valued at $22,278,969, in 1914, against 77,764,049 short tons, valued at $22,321,517, in 1913; 66,889,175 short tons, valued at $21,682,737, in 1912; 65,308,293 short tons, valued at $19,614,850, in 1911; and 67,949,347 short tons, valued at $19,520,919, in 1910. The imports of sand for consumption were valued at $139,675 in 1914, $172,257 in 1913, and $141,690 in 1912.

Sand-lime brick.—The production of sand-lime brick was valued at $1,058,512 in 1914, $1,238,325 in 1913, $1,200,223 in 1912, $897,664 in 1911, and $1,169,153 in 1910.

Silica (quartz).—The production of silica (quartz) in 1914 was 153,401 short tons, valued at $360,502, against 97,902 short tons, valued at $201,488, in 1913; 97,874 short tons, valued at $191,685, in 1912; 87,943 short tons, valued at $155,122, in 1911; and 63,577 short tons, valued at $193,757, in 1910. The value of the flint and flint pebbles imported for consumption in 1914 was $432,694, against $324,662 in 1913, $289,904 in 1912, $236,158 in 1911, and $307,286 in 1910.

Slate.—The production of slate in 1914 was valued at $5,706,787, against $6,175,476 in 1913, $6,043,318 in 1912, $5,728,019 in 1911, and $6,236,759 in 1910. The imports of slate (in the form of mantels, chimney pieces, roofing slate, slabs, etc.) were valued at $4,855 in 1914 and at $5,479 in 1913, and the exports of slate in these years were valued at $139,125 and $226,413, respectively.

Sodium nitrate.—The imports of sodium nitrate for consumption amounted in value to $15,204,539 in 1914, $21,630,811 in 1913, and $16,544,511 in 1912. There is no domestic production of sodium nitrate.

Stone.—The value of all kinds of stone produced in the United States in 1914 amounted to $77,412,292, compared with $83,732,995 in 1913, $78,193,220 in 1912, $77,108,567 in 1911, and $76,520,584 in 1910. The imports of stone for consumption were valued in 1914 at $1,389,473, against $1,615,152 in 1913, and $1,562,231 in 1912; the exports were valued at $1,363,242 in 1914, against $1,856,892 in 1913, and $1,839,878 in 1912. Included under stone is the limestone used

for fluxing in blast furnaces, which amounted to 15,298,756 long tons, valued at $7,890,369, in 1914, compared with 22,620,961 long tons, valued at $11,103,989, in 1913; 20,190,554 long tons, valued at $9,937,772, in 1912; 16,126,650 long tons, valued at $7,987,208, in 1911; and 18,203,882 long tons, valued at $9,345,733, in 1910.

Sulphur.—The marketed production of sulphur in 1914 was 327,634 long tons, valued at $5,954,236, against 311,590 long tons, valued at $5,479,849, in 1913; 303,472 long tons, valued at $5,256,422, in 1912; 265,664 long tons, valued at $4,787,049, in 1911; and 255,534 long tons, valued at $4,605,112, in 1910. The imports of sulphur for consumption fell in value from $558,611 in 1910 to $552,836 in 1911, rose to $583,974 in 1912, fell to $448,564 in 1913, and rose to $477,937 in 1914. The exports amounted to 98,153 long tons, valued at $1,807,334, in 1914; 89,221 long tons, valued at $1,599,761, in 1913; 57,736 long tons, valued at $1,076,414, in 1912; 28,103 long tons, valued at $545,420, in 1911; and 30,742 long tons, valued at $552,941, in 1910.

Sulphuric acid from copper and zinc smelters.—The statistics of the recovery of sulphuric acid from the gases from copper and zinc smelters were collected by the Survey for the first time in 1911. This production amounted to 760,638 short tons (60° Baumé), valued at $5,190,293, in 1914; 632,237 short tons, valued at $4,346,272, in 1913; 614,073 short tons, valued at $4,240,941, in 1912; and 438,300 short tons, valued at $2,733,696, in 1911.

Talc and soapstone.—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of talc and soapstone in 1914 amounted to 86,221 short tons, valued at $1,043,801, compared with 94,128 short tons, valued at $1,119,597, in 1913; 93,413 short tons, valued at $1,050,693, in 1912; 81,521 short tons, valued at $1,032,732, in 1911; and 79,006 short tons, valued at $864,213, in 1910. The imports of talc for consumption were valued at $177,321 in 1914, $137,680 in 1913, and $122,956 in 1912. In 1914 the production of fibrous talc was 86,075 short tons, valued at $821,286, against 81,705 short tons, valued at $788,500, in 1913; 66,867 short tons, valued at $656,270, in 1912; 62,030 short tons, valued at $613,286, in 1911; and 71,710 short tons, valued at $728,180, in 1910.

Thorium minerals (monazite) and zircon.—The production of monazite declined from a maximum of 1,352,418 pounds (including a few pounds of zircon and columbite), valued at $163,908, in 1905, to 99,301 pounds, valued at $12,006, in 1910. There has been no production of monazite since 1910, and the gas-mantle industry of the United States has been supplied by imports of monazite from Brazil and of manufactured thorium salts from Germany. The imports of thorium nitrate for consumption were 101,927 pounds, valued at $239,376, in 1914, against 119,044 pounds, valued at $230,628, in 1913; 117,485 pounds, valued at $225,386, in 1912; 121,111 pounds, valued at $238,841, in 1911; and 124,808 pounds, valued at $219,615, in 1910. The imports of monazite and thorium oxide in 1914 were valued at $63,282, against $68,542 in 1913, $47,334 in 1912, and $60,542 in 1911. The production of zircon has always been irregular in the United States, but has been smaller in the last several years than before. From a production of 26 tons in 1883 the production has declined to a few thousand pounds each year, and to nothing in 1912, 1913, and 1914.

MINERAL PRODUCTS IN 1913 AND 1914.

From the total shown in the following table, "Mineral products of the United States in 1913 and 1914," duplication has been eliminated wherever practicable. For instance, the value of the coke has been excluded from the total as the value of the coal used in its manufacture enters into the statistics of coal production. In mineral paints, the chemically manufactured pigments (white lead, red lead, lithopone, Venetian red, litharge, and orange mineral), whose aggregate value has exceeded $20,000,000 annually for the last 10 years, are not given in the table, as the base from which they are made is included in the output of lead; whereas the zinc and lead pigments (zinc white or zinc oxide, zinc-lead, leaded zinc oxide, sublimed blue lead, and sublimed white lead) are included, being made directly from the ores and not entering, therefore, into the lead or zinc totals. The value of the pig iron, rather than of the iron ore, is included in the total, being considered the best means of presenting the statistics of iron in its first marketable condition. Similarly, the value of the products of the clay industries is included as representing the first marketable condition of the greater part of the clay produced. The quantity and value of the clay mined and sold in the raw state by miners to manufacturers of clay are shown separately, but the value is not included in the total.

The figures for gold and silver are those agreed upon by the United States Geological Survey and the Director of the Mint.

Mineral products of the United States in 1913 and 1914.

Product.	1913		1914		Increase (+) or decrease (−) in 1914.		Percentage of increase (+) or decrease (−) in 1914.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.								
Aluminum (consumption) ..... pounds..	72,379,000	$13,845,000	79,129,000	$14,522,700	+ 6,750,000	+ $677,700	+ 9.33	+ 4.89
Antimonial lead [a] ..... short tons (2,000 pounds)..	16,665	1,591,854	16,667	1,572,167	+ 2	− 19,687	+ .01	− 1.24
Antimony [b] ..... do....	2,508	[b] 429,363	2,705	[b] 576,501	+ 197	+ [b] 147,138	+ 7.85	+ 34.27
Bauxite ..... long tons (2,240 pounds)..	210,241	997,698	219,318	1,069,194	+ 9,077	+ 71,496	+ 4.32	+ 7.17
Chromic iron ore ..... do....	255	2,854	591	8,715	+ 336	+ 5,861	+131.76	+205.36
Copper, [c] value at New York City ..... pounds..	1,224,484,098	189,795,035	1,150,137,192	152,968,246	−74,346,906	− 36,826,789	− 6.07	− 19.40
Ferro-alloys ..... long tons..	296,207	13,015,362	255,524	9,350,245	− 40,683	− 3,665,117	− 13.73	− 28.16
Gold [d] ..... troy ounces..	4,299,784	88,884,400	4,572,976	94,531,800	+ 273,192	+ 5,647,400	+ 6.35	+ 6.35
Iron ore [e] ..... long tons..	59,643,098	[e] 130,905,558	39,714,280	[e] 71,905,079	−19,928,818	−59,000,479	− 33.41	− 45.07
Iron pig ..... do....	30,388,935	458,342,345	22,263,263	298,777,429	− 8,125,672	−159,564,916	− 26.74	− 34.81
Lead (refined), [c] value at New York City ..... short tons..	411,878	36,245,264	512,794	39,997,932	+ 100,916	+ 3,752,668	+ 24.50	+ 10.35
Manganese ore ..... long tons..	4,048	40,480	2,635	27,377	− 1,413	− 13,103	− 34.91	− 32.37
Manganiferous ore [f] ..... do....	59,403	25,124	98,265	218,497	+ 38,862	+ 193,373	+ 65.42	+769.67
Nickel, [g] value at New York City ..... pounds..	481,565	79,393	845,334	313,000	+ 363,769	+ 233,607	+ 75.54	+294.24
Platinum and allied metals, value at New York City ..... troy ounces..	1,034	46,530	6,324	280,885	+ 5,290	+ 234,355	+511.61	+503.66
Quicksilver, value at San Francisco.. flasks (75 pounds net)..	20,213	813,171	16,548	811,680	− 3,665	− 1,491	− 18.13	− .18
Silver ..... troy ounces..	66,801,500	40,348,100	72,455,100	40,067,700	+ 5,653,600	− 280,400	+ 8.46	− .69
Tin (metallic equivalent) ..... pounds..	.....	46,699	208,000	66,560	.....	+ 19,861	.....	+ 42.53
Titanium ore (rutile) ..... short tons..	305	49,000	94	11,280	− 211	− 37,720	− 69.18	− 76.98
Tungsten ore (60 per cent concentrates) ..... do....	1,537	672,118	990	435,000	− 547	− 237,118	− 35.59	− 35.28
Uranium and vanadium minerals [h] ..... do....	(h)	[h] 699,361	(h)	[h] 941,300	.....	+ 331,939	.....	+ 54.47
Zinc, [c] value at St. Louis ..... do....	337,252	37,772,224	343,418	35,028,636	+ 6,166	− 2,743,588	+ 1.83	− 7.26
Total value of metallic products	.....	883,222,012	.....	691,000,343	.....	−192,221,669	.....	− 21.76
NONMETALLIC.								
Arsenious oxide ..... short tons..	2,513	159,236	4,670	313,147	+ 2,157	+ 153,911	+ 85.83	+ 96.66
Asbestos ..... do....	1,100	11,000	1,247	18,965	+ 147	+ 7,965	+ 13.36	+ 72.41
Asphalt ..... do....	529,190	5,282,370	438,271	3,647,592	− 90,919	− 1,634,778	− 17.18	− 30.95
Barytes (crude) ..... do....	45,298	156,275	51,547	153,715	+ 6,249	− 2,560	+ 13.80	− 1.64
Borax (crude) ..... do....	58,051	1,491,530	62,400	1,464,400	+ 4,349	− 27,130	+ 7.49	− 1.82
Bromine ..... pounds..	572,400	115,436	576,991	203,094	+ 4,591	+ 87,658	+ .80	+ 75.94
Calcium chloride ..... short tons..	19,611	130,030	19,403	121,766	− 208	− 8,264	− 1.06	− 6.36
Cement ..... barrels (380 pounds, net)..	89,541,348	89,550,527	87,257,552	80,533,203	− 2,283,796	− 9,017,324	− 2.55	− 10.07
Clay products	.....	181,289,132	.....	164,986,983	.....	− 16,302,149	.....	− 8.99
Clay raw [e] ..... short tons..	2,647,989	[e] 4,180,459	2,209,860	[e] 3,756,568	− 438,129	− [e] 423,891	− 16.55	− 10.14

Coal{bituminous [i]	do	478,435,297	565,234,952	422,703,970	493,309,244	−55,731,327	− 71,925,708	− 11.65	− 12.72
Coal{Pennsylvania anthracite	long tons	81,718,680	195,181,127	81,090,631	188,181,399	− 628,049	− 6,999,728	− .77	− 3.59
Cobalt oxide	pounds								
Coke [e]	short tons	46,299,530	[e] 128,922,273	34,555,914	[e] 88,334,217	−11,743,616	−[e]40,588,056	− 25.36	− 31.48
Diatomaceous (infusorial) earth and tripoli			285,821		252,327		− 33,494		− 11.72
Emery	short tons	957	4,785	485	2,425	− 472	− 2,360	− 49.32	− 49.32
Feldspar	do	120,955	776,551	135,419	629,873	+ 14,464	− 146,678	+ 11.96	− 18.89
Fluorspar	do	115,580	736,286	95,116	570,041	− 20,464	− 166,245	− 17.71	− 22.58
Fuller's earth	do	38,594	369,750	40,981	403,646	+ 2,387	+ 33,896	+ 6.18	+ 9.17
Garnet for abrasive purposes	do	5,308	183,422	4,231	145,510	− 1,077	− 37,912	− 20.29	− 20.67
Gems and precious stones			319,454		124,651		− 194,803		− 60.98
Graphite{amorphous	short tons	2,243	39,428	1,725	38,750	− 518	− 678	− 23.09	− 1.72
Graphite{crystalline	pounds	5,064,727	254,328	5,220,539	285,368	+ 155,812	+ 31,040	+ 3.08	+ 12.20
Grindstones and pulpstones			855,627		689,344		− 166,283		− 19.43
Gypsum	short tons	2,599,508	6,774,822	2,476,465	6,895,989	− 123,043	+ 121,167	− 4.73	+ 1.79
Lime	do	3,595,390	14,648,362	3,380,928	13,247,676	− 214,462	− 1,400,686	− 5.96	− 9.56
Lithium minerals	do	(j)	(j)	(j)	(j)	(j)	(j)	(j)	(j)
Magnesite (crude)	do	9,632	77,056	11,293	124,223	+ 1,661	+ 47,167	+ 17.24	+ 61.21
Marls	do	(j)	(j)	(j)	(j)	(j)	(j)	(j)	(j)
Mica{scrap	do	5,322	82,543	3,730	51,416	− 1,592	− 31,127	− 29.91	− 37.71
Mica{sheet	pounds	1,700,677	353,517	556,933	278,540	− 1,143,744	− 74,977	− 67.25	− 21.21
Millstones			56,163		43,316		− 12,847		− 22.87
Mineral paints{natural pigments [k]	short tons	70,595	512,410	66,766	473,036	− 3,829	− 39,374	− 5.42	− 7.68
Mineral paints{zinc and lead pigments [k]	do	97,573	9,020,896	106,791	9,978,710	+ 9,218	+ 957,814	+ 9.45	+ 10.62
Mineral waters	gallons sold	57,867,399	5,631,391	54,358,466	4,892,328	− 3,508,933	− 739,063	− 6.06	− 13.12
Natural gas			87,846,677		94,115,524		+ 6,268,847		+ 7.14
Oilstones, etc			207,352		167,948		− 39,404		− 19.00
Peat			197,200		309,692		+ 112,492		+ 57.04
Petroleum	barrels (42 gallons)	248,446,230	237,121,388	265,762,535	214,125,215	+17,316,305	− 22,996,173	+ 6.97	− 9.70
Phosphate rock	long tons	3,111,221	11,796,231	2,734,043	9,608,041	− 377,178	− 2,188,190	− 12.12	− 18.55
Pumice	short tons	24,563	55,408	27,591	59,172	+ 3,028	+ 3,764	+ 12.33	+ 6.79
Pyrite	long tons	341,338	1,286,084	336,662	1,283,346	− 4,676	− 2,738	− 1.37	− .21
Salt	barrels (280 pounds, net)	34,399,298	10,123,139	34,804,683	10,271,358	+ 405,385	+ 148,219	+ 1.18	+ 1.46
Sand{glass	short tons	1,791,800	1,895,991	1,619,649	1,568,030	− 172,151	− 327,961	− 9.61	− 17.30
Sand{molding, building, etc., and gravel	do	77,764,049	22,321,517	77,662,086	22,278,969	− 101,963	− 42,548	− .13	− .19

[a] From both domestic and foreign ores. 1914: Domestic, 15,475 tons, $1,462,051; foreign, 1,192 tons, $110,116.

[b] Antimony contained in antimonial lead and antimony saved in refining copper. Values excluded from metallic total as values of the former are included in value of antimonial lead and of the latter under "Unspecified."

[c] Product from domestic ores only.

[d] Value, $20.671834625323 an ounce.

[e] Value not included in total value.

[f] Exclusive of those ores from Lake Superior district running so low in manganese as to be classed with iron ore.

[g] By-product in electrolytic refining of copper.

[h] 1913: Consists of 2,269 tons of uranium ore (carnotite); 10.5 grams of radium, not isolated; and 432 tons of vanadium in roscoelite and carnotite ores with an arbitrarily assigned value. 1914: 4,294 tons of uranium ore (carnotite), valued at $441,300 (including the value of 22.3 grams of radium, not isolated), and 452 tons of vanadium in roscoelite and carnotite ores, with an arbitrarily assigned value of $500,000.

[i] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.

[j] Value included under "Unspecified."

[k] Natural pigments: Ocher, umber, sienna, metallic paint, mortar colors, and ground slate and shale. Zinc and lead pigments: Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.

Mineral products of the United States in 1913 and 1914—Continued.

Product.	1913		1914		Increase (+) or decrease (−) in 1914.		Percentage of increase (+) or decrease (−) in 1914.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
NONMETALLIC—continued.								
Sand-lime brick		$1,238,325		$1,058,512		− $179,813		− 14.52
Silica (quartz) short tons	97,902	201,488	153,401	360,502	+ 55,499	+ 159,014	+ 56.69	+ 78.92
Slate		6,175,476		5,706,787		− 468,689		− 7.59
Stone		83,732,995		77,412,292		− 6,320,703		− 7.55
Sulphur long tons	311,590	5,479,849	327,634	5,954,236	+ 16,044	+ 474,387	+ 5.15	+ 8.66
Sulphuric acid (60° Baumé) from copper and zinc smelters short tons	632,237	4,346,272	760,638	5,190,293	+ 128,401	+ 844,021	+ 20.31	+ 19.42
Talc and soapstone (exclusive of fibrous talc) do	94,128	1,119,597	86,221	1,043,801	− 7,907	− 75,796	− 8.40	− 6.77
Talc, fibrous do	81,705	788,500	86,075	821,286	+ 4,370	+ 32,786	+ 5.35	+ 4.16
Thorium minerals (monazite) and zircon pounds								
Total value of nonmetallic products		1,555,517,716		1,423,395,681		−132,122,035		− 8.49
Total value of metallic products		883,222,012		691,000,343		−192,221,669		− 21.76
UNSPECIFIED.[a]								
Metallic and nonmetallic (estimate)		420,000		[a] 550,000		+ 130,000		+ 30.95
Grand total		2,439,159,728		2,114,946,024		−324,213,704		− 13.29

[a] Includes, in 1914, bismuth, cadmium, ilmenite, lithium, marls, molybdenum, selenium, and an estimate of the value of miscellaneous mineral products not collected annually by the Survey.

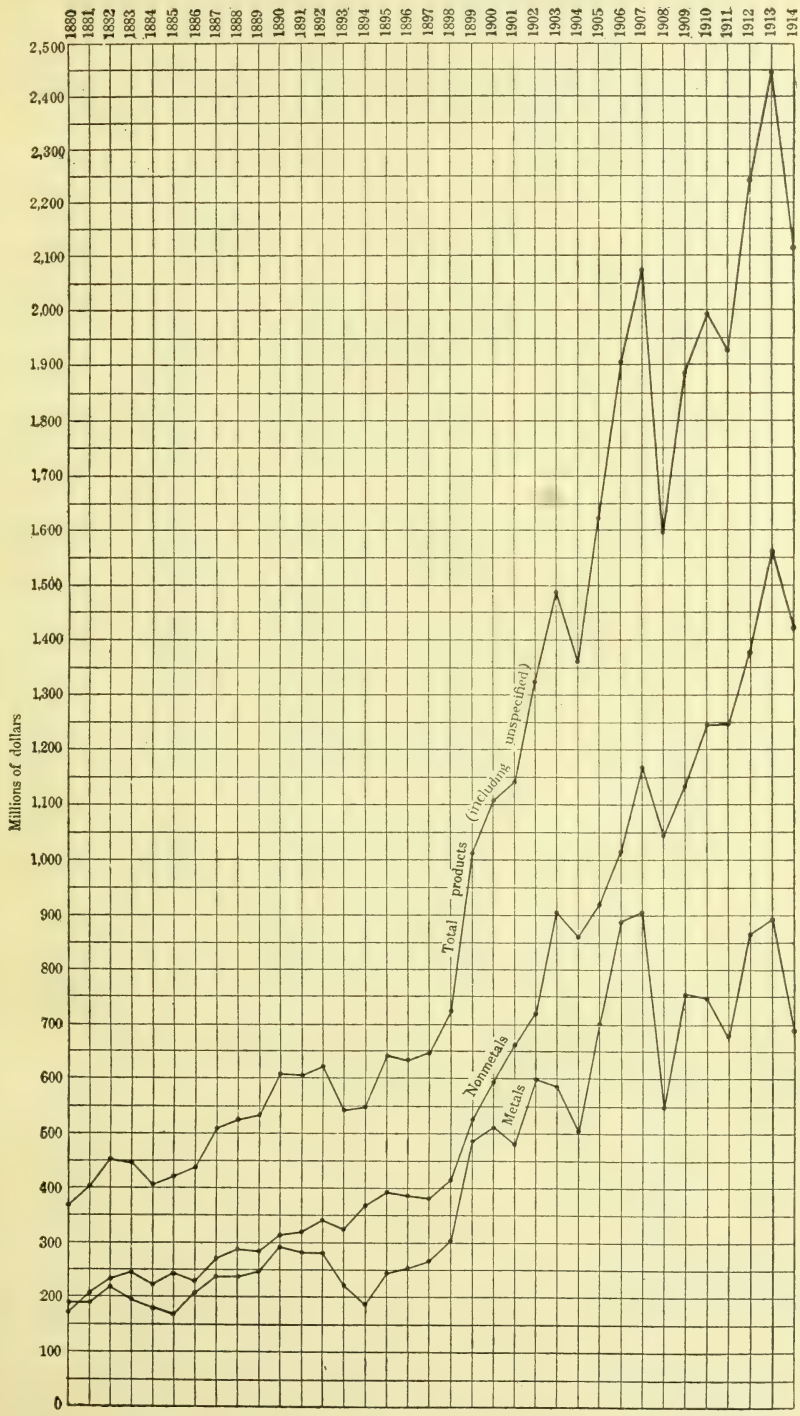

FIGURE A.—Curves showing value of mineral products of the United States, 1880–1914.

TOTAL VALUE OF MINERAL PRODUCTS OF THE UNITED STATES FROM 1880 TO 1914.

The following table and the diagram on page *27 show the value, year by year, of the mineral products of the United States as reported to the United States Geological Survey from 1880 to 1914, inclusive:

Total value of mineral products of the United States from 1880 to 1914, by years.

Year.	Metallic.	Nonmetallic.	Unspecified (metallic and nonmetallic).	Total.
1880	$185,649,163	$173,279,135	$6,000,000	$364,928,298
1881	187,549,908	206,783,144	6,500,000	400,833,052
1882	214,061,009	231,340,150	6,500,000	451,901,159
1883	196,547,259	243,812,214	6,500,000	446,859,473
1884	179,230,899	221,879,506	5,000,000	406,110,405
1885	172,491,087	241,312,093	5,000,000	418,803,180
1886	203,249,225	230,088,769	800,000	434,137,994
1887	236,598,254	270,989,420	800,000	508,387,674
1888	237,574,422	286,150,114	900,000	524,624,536
1889	247,768,701	282,623,812	1,000,000	531,392,513
1890	292,649,877	312,826,503	1,000,000	606,476,380
1891	282,617,183	321,767,846	1,000,000	605,385,029
1892	281,514,539	340,028 842	1,000,000	622,543,381
1893	219,436,649	323,257,318	1,000,000	543,693,967
1894	185,804,594	362,570,173	1,000,000	549,374,767
1895	245,874,431	393,897,097	1,000,000	640,771,528
1896	251,445,519	388,098,702	1,000,000	640,544,221
1897	265,209,975	380,782,607	1,000,000	646,992,582
1898	305,482,183	417,790,671	1,000,000	724,272,854
1899	487,831,631	525,524,074	1,000,000	1,014,355,705
1900	511,632,891	594,398,501	1,000,000	1,107,031,392
1901	480,006,859	660,850,112	1,000,000	1,141,856,971
1902	599,916,009	722,027,126	1,000,000	1,322,943,135
1903	583,433,948	905,242,380	1,000,000	1,489,676,328
1904	502,149,624	859,543,144	400,000	1,362,092,768
1905	702,083,261	921,181,524	400,000	1,623,664,785
1906	886,639,372	1,016,390,015	200,000	1,903,229,387
1907	904,093,201	1,165,748,197	100,000	2,069,941,398
1908	550,744,388	1,043,702,454	250,000	1,594,696,842
1909	754,940,809	1,131,515,921	300,000	1,886,756,730
1910	749,876,234	1,241,039,986	300,000	1,991,216,220
1911	680,888,929	1,245,145,079	250,000	1,926,284,008
1912	866,381,073	1,377,152,760	500,000	2,244,033,833
1913	883,222,612	1,555,517,716	420,000	2,439,159,728
1914	691,000,343	1,423,395,681	550,000	2,114,946,024
Grand total	15,225,595,461	22,017,652,786	56,670,000	37,299,918,247

IMPORTS AND EXPORTS.

Value of imports for consumption and of exports of mineral products in the calendar years 1913 and 1914.

Metallic products.

Product.	1913	1914
IMPORTS.		
Aluminum salts	$66,549	$73,028
Antimony (crude and ore)	137,780	75,345
Antimony (metal and regulus)	798,581	736,420
Antimony (oxide and salts of)	117,169	315,001
Bauxite	85,746	96,500
Bismuth	213,257	165,208
Cadmium	1,232	368
Chromic iron ore	622,821	695,645
Chromium salts	2,919	3,972
Cobalt (oxide ore and zaffer)	95,735	274,538
Copper in ore, matte, ingots, bars, manufactures, etc	57,639,490	39,491,973
Iron ore	8,332,777	4,482,242

Value of imports for consumption and of exports of mineral products in the calendar years 1913 and 1914—Continued.

Metallic products—Continued.

Product.	1913	1914
IMPORTS—continued.		
Ferro-alloys:		
Ferrochrome (and chromium)	$51,415	$21,553
Ferromanganese (and manganese)	5,682,915	3,619,607
Ferromolybdenum (and molybdenum)	15,939	59
Ferrophosphorus	.....	1,136
Ferrosilicon	449,871	341,925
Ferrotitanium (and titanium)	7,198	8,356
Ferrotungsten (and tungsten)	835,212	222,447
Ferrovanadium	.....	.....
Spiegeleisen	2,173	71,147
Lead, in ore, base bullion, pigs, sheets, manufactures, etc	572,980	504,978
Manganese ore	2,029,680	2,024,120
Nickel, in ore, matte, oxide, etc	6,600,755	5,028,818
Platinum and allied metals:		
Platinum	5,040,210	2,908,353
Iridium, osmium, palladium, rhodium, and ruthenium	707,194	184,458
Osmiridium	11,872	84,363
Quicksilver	75,361	271,984
Tin	46,946,756	32,943,059
Tungsten	213,122	139,687
Type metal	20,098	45,373
Uranium salts and oxide, including some radium salts	34,319	63,055
Zinc, in ore, pigs, sheets, dust, manufactures, etc	1,079,994	425,205
Total	138,491,120	95,319,923
Decrease	.....	43,171,197
Percentage of decrease	.....	31.17
EXPORTS.		
Aluminum and manufactures, etc	966,094	1,546,510
Copper, in ore, matte, ingots, bars, etc	146,327,621	117,633,145
Iron:		
Ore	3,513,419	1,794,193
Pig	4,026,306	1,638,102
Lead, in ore, base bullion, pigs, sheets, manufactures, etc	738,135	5,519,908
Nickel, in ore, matte, oxide, etc	9,686,794	9,455,528
Quicksilver	43,574	70,753
Zinc, in ore, pigs, sheets, dust, manufactures, etc	1,735,099	9,381,050
Total	167,037,042	147,039,189
Decrease	.....	19,997,853
Percentage of decrease	.....	11.97

Nonmetallic products.

IMPORTS.		
Alizarin	$1,493,840	$1,216,907
Aniline salts	323,420	180,905
Arsenic sulphides, etc	410,446	273,713
Asbestos	2,307,666	1,779,223
Asphalt	910,611	675,618
Barytes	99,564	77,265
Barium compounds	391,470	470,499
Borax	18,534	19,412
Burrstones and millstones	40,198	15,000
Cement, hydraulic	139,416	194,053
Clay, other than kaolin	382,782	359,993
Clay products:		
Brick and tile	276,677	207,644
Pottery, etc	10,177,451	8,349,442
Coal:		
Anthracite	5,620	25,380
Bituminous	3,853,930	3,902,881
Coal-tar products (exclusive of alizarin, aniline salts, and salicylic acid)	9,142,599	8,239,142
Coke	435,157	551,104
Corundum and emery	474,299	383,436
Cryolite	52,557	94,424
Diatomaceous earth, rottenstone, and tripoli	28,696	20,004
Fertilizers:		
Crude (guano, kanite, manure salts, phosphates, etc)	10,819,253	9,921,439
Potassium chloride	7,075,745	5,745,385
Potassium sulphate	1,677,429	1,557,224
Other potassium salts	2,052,546	1,441,364
Sodium nitrate	21,630,811	15,204,539

Value of imports for consumption and of exports of mineral products in the calendar years 1913 and 1914—Continued.

Nonmetallic products—Continued.

Product.	1913	1914
IMPORTS—continued.		
Flint and flint pebbles	$324,662	$432,694
Fluorspar	71,463	38,943
Fuller's earth	146,001	195,083
Gems and precious stones	45,431,998	19,211,084
Granite	115,525	158,057
Graphite	2,109,791	1,398,209
Grindstones	139,386	109,539
Gypsum	556,922	444,841
Hones, oilstones, whetstones	40,222	33,655
Kaolin, or china clay	1,623,993	1,927,425
Lead paints, litharge, orange mineral, red lead, white lead	74,124	61,330
Lime	48,538	33,670
Magnesite and magnesia	1,805,274	1,453,508
Marble and stone (exclusive of granite)	1,499,627	1,231,416
Mica	943,018	625,396
Mineral waters	955,788	857,707
Monazite and thorium oxide	68,542	63,282
Ocher	143,720	141,704
Peat	55,719	57,542
Petroleum and petroleum products:		
Petroleum	12,945,619	11,464,879
Gasoline	1,661	587
Ozokerite and paraffin	982,352	860,921
Pumice	93,408	92,668
Pyrite	3,611,137	4,797,326
Salicylic acid	2,969	9,245
Salt	421,745	380,803
Sand	172,257	139,675
Sienna	48,535	63,958
Slate	5,479	4,855
Strontium salts	2,284	1,016
Sulphur	448,564	477,937
Talc	137,680	177,321
Thorium nitrate	230,628	239,376
Umber	36,771	45,280
Venetian red	25,927	29,300
Zinc oxide	434,156	302,838
Total	149,976,202	108,469,066
Decrease		41,507,136
Percentage of decrease		27.68
Grand total imports	288,467,322	203,788,989
Decrease		84,678,333
Percentage of decrease		29.35
EXPORTS.		
Asphalt	1,679,411	1,247,020
Cement, hydraulic	4,270,666	3,088,809
Clay products		
Brick and tile, etc	4,228,908	3,051,103
Pottery, etc	559,331	526,902
Coal:		
Anthracite	21,959,850	20,211,072
Bituminous	[a] 45,449,664	[a] 34,104,903
Coke	3,309,930	2,233,686
Fertilizer, phosphates, crude	9,996,580	6,771,652
Lime	212,345	170,744
Marble and stone	1,856,892	1,363,242
Petroleum and petroleum products:		
Petroleum	131,897,632	120,002,974
Gasoline	17,418,777	19,897,613
Paraffin and paraffin wax	8,176,831	6,434,831
Salt	515,194	586,055
Slate	226,413	139,125
Sulphur	1,599,761	1,807,334
Zinc oxide	1,136,257	1,408,525
Total	254,494,442	223,045,590
Decrease		31,448,852
Percentage of decrease		12.36
Grand total exports	421,531,484	370,084,779
Decrease		51,446,705
Percentage of decrease		12.20

[a] Not including bunker coal laden as fuel in vessels in the foreign trade, which aggregated in value $25,036,272 in 1913 and $24,145,735 in 1914.

If gold and silver are included, for the sake of rounding out the metals mentioned in this report, the metallic imports decreased from $238,063,771 in 1913 to $178,666,851 in 1914, and the metallic exports increased from $321,612,283 in 1913 to $421,258,405 in 1914; the total imports decreased from $388,039,973 in 1913 to $287,135,917 in 1914, and the total exports increased from $576,106,725 in 1913, to $644,303,995 in 1914. The movements of gold and silver, however, are rather financial than commercial; nevertheless the following table is added to show the results mentioned above:

Value of imports for consumption and of exports of mineral products in the calendar years 1913 and 1914, including gold and silver.

Product.	1913	1914
IMPORTS.		
Gold (ore, bullion, and coin)	$63,704,832	$57,387,741
Silver (ore, bullion, and coin)	35,867,819	25,959,187
Other metallic products	138,491,120	95,319,923
Total	238,063,771	178,666,851
Total metallic products	238,063,771	178,666,851
Total nonmetallic products	149,976,202	108,469,066
Grand total	388,039,973	287,135,917
EXPORTS.		
Gold (ore, bullion, and coin)	91,798,610	222,616,156
Silver (ore, bullion, and coin)	62,776,631	51,603,060
Other metallic products	167,037,042	147,039,189
Total	321,612,283	421,258,405
Total metallic products	321,612,283	421,258,405
Total nonmetallic products	254,494,442	223,045,590
Grand total	576,106,725	644,303,995

REVIEW BY STATES.

GENERAL.

In the following tables are shown (1) the value of the mineral production of the United States in 1913 and 1914 arranged by States in order of productive value in 1914, with leading products of each State; (2) the quantity and value of the principal metals, fuels, and structural materials in 1913 and 1914, with States leading in 1914 in the production of each mineral.

Rank of States in value of mineral production in 1913 and 1914.

State.	Principal mineral products in 1914 (in order of value).	1913		1914			
		Rank.	Value.	Rank.	Value.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
Pennsylvania	Coal, clay products, cement, natural gas	1	$506,341,809	1	$452,374,085	−$53,967,724	−10.66
West Virginia	Coal, natural gas, petroleum, clay products	2	143,591,272	2	134,071,803	− 9,519,469	− 6.63
Illinois	Coal, petroleum, clay products, cement	3	131,825,221	3	117,145,108	− 14,680,113	−11.14
Ohio	Clay products, coal, natural gas, petroleum	4	121,795,892	4	101,661,384	− 20,134,508	−16.53
California	Petroleum, gold, cement, stone	5	100,791,369	5	101,087,140	+ 295,771	+ .29
Oklahoma	Petroleum, coal, natural gas, zinc	7	80,168,820	6	78,744,447	− 1,424,373	− 1.78
Arizona	Copper, gold, silver, lead	9	71,429,705	7	60,391,272	− 11,038,433	−15.45
Michigan	Copper, iron ore, cement, salt	8	72,143,211	8	57,732,447	− 14,410,764	−19.98
Montana	Copper, silver, zinc, coal	10	69,307,056	9	54,244,889	− 15,062,167	−21.73
Colorado	Gold, coal, zinc, silver	11	54,294,281	10	52,161,660	− 2,132,621	− 3.93
Missouri	Lead, zinc, coal, clay products	12	54,001,088	11	48,597,593	− 5,403,495	−10.01
Minnesota	Iron ore, clay products, stone, sand and gravel	6	85,814,533	12	45,680,865	− 40,133,668	−46.77
Utah	Copper, lead, silver, coal	13	53,606,520	13	45,624,698	− 7,981,822	−14.89
Indiana	Coal, cement, clay products, stone	14	46,502,633	14	42,864,267	− 3,638,366	− 7.82
New York	Clay products, stone, cement, salt	15	41,709,002	15	36,307,036	− 5,401,966	−12.95
New Jersey	Clay products, zinc, cement, sand and gravel	17	35,931,191	16	31,756,503	− 4,174,688	−11.62
Alabama	Coal, iron ore, clay products, stone	18	34,660,545	17	30,879,288	− 3,781,257	−10.91
Texas	Petroleum, coal, cement, natural gas	19	31,666,910	18	30,363,426	− 1,303,484	− 4.12
Nevada	Gold, silver, copper, zinc	16	37,842,084	19	29,984,338	− 7,857,746	−20.76
Kentucky	Coal, clay products, stone, sand and gravel	21	26,845,579	20	26,668,474	− 177,105	− .66
Iowa	Coal, clay products, cement, gypsum	22	25,602,015	21	26,287,115	+ 685,100	+ 2.68
Kansas	Coal, natural gas, cement, petroleum	20	27,312,563	22	25,866,351	− 1,446,212	− 5.30
Idaho	Lead, silver, zinc, gold	23	24,565,826	23	24,913,223	+ 347,397	+ 1.41
Louisiana	Petroleum, sulphur, natural gas, clay products	25	21,011,828	24	21,890,025	+ 878,197	+ 4.18
Tennessee	Coal, copper, stone, phosphate rock	24	21,008,938	25	19,645,213	− 1,363,725	− 6.49
Alaska	Gold, copper, silver, stone	26	19,645,498	26	19,175,707	− 469,791	− 2.39
New Mexico	Copper, coal, gold, silver	27	17,862,369	27	18,072,919	+ 210,550	+ 1.18
Virginia	Coal, stone, clay products, lime	29	17,178,580	28	16,400,347	− 778,233	− 4.53
Washington	Coal, cement, clay products, stone	28	17,579,743	29	13,830,739	− 3,749,004	−21.33
Wyoming	Coal, petroleum, iron ore, gypsum	30	13,682,091	30	12,417,752	− 1,264,339	− 9.24
Wisconsin	Zinc, stone, iron ore, clay products	31	12,452,480	31	11,022,643	− 1,429,837	−11.48
Maryland	Coal, clay products, cement, stone	32	11,292,723	32	10,587,564	− 705,159	− 6.24
Vermont	Stone, slate, talc and soapstone	34	9,647,985	33	8,665,867	− 982,118	−10.18
Florida	Phosphate rock, stone, fuller's earth, clay products	33	10,508,016	34	8,497,688	− 2,010,328	−19.13
South Dakota	Gold, stone, silver	35	7,909,059	35	7,861,601	− 47,458	− .60
Massachusetts	Stone, clay products, lime, sand and gravel	36	7,044,529	36	6,292,833	− 751,696	−10.67
Arkansas	Coal, bauxite, clay products, stone	37	6,780,760	37	5,785,199	− 995,561	−14.68
Georgia	Clay products, stone, cement, coal	38	6,525,792	38	5,695,084	− 830,708	−12.73
Maine	Stone, clay products, lime, mineral waters	39	4,429,584	39	3,975,890	− 453,694	−10.24
North Carolina	Clay products, stone, mica	41	3,739,696	40	3,519,245	− 220,451	− 5.89

Oregon	Gold, clay products, stone, sand and gravel	42	3,563,919	41	3,331,132	232,787	−6.53
Connecticut	Clay products, stone, lime, mineral waters	40	3,795,297	42	3,023,192	772,105	−20.34
New Hampshire	Stone, clay products, sand and gravel	43	2,218,925	43	2,029,835	189,090	−8.52
South Carolina	Clay products, phosphate rock, stone	44	1,464,150	44	1,414,294	49,856	−3.41
Nebraska	Clay products, stone, sand and gravel	45	1,433,718	45	1,166,787	266,931	−18.62
Mississippi	Clay products, sand and gravel, mineral waters	46	1,143,472	46	1,104,197	39,275	−3.43
North Dakota	Coal, clay products	47	1,055,676	47	1,063,540	7,864	+.74
Rhode Island	Stone, clay products	48	813,952	48	777,716	36,236	−4.45
Delaware	Clay products, stone, sand and gravel	49	541,542	49	288,516	253,026	−46.72
District of Columbia	Clay products, sand and gravel, sand-lime brick	50	246,582	50	219,680	26,902	−10.91

Production and value of principal metals, fuels, and structural materials in the United States, 1913 and 1914.

Mineral.	Principal producing States in 1914 (in order of value).[a]	1913			1914						
								Increase (+) or decrease (−) in value.			
								By minerals.		By groups.	
		Quantity.	Value.	Value by groups.	Quantity.	Value.	Value by groups.	Amount.	Per-centage.	Amount.	Per-centage.
Metals (from domestic ores):											
Pig iron..long tons..	Pennsylvania, Ohio, Illinois, New York.	29,145,034	$439,633,756		21,459,852	$287,312,794		−$152,320,962	−34.65		
Copper....pounds..	Arizona, Montana, Michigan, Utah.	1,224,484,098	189,795,035		1,150,137,192	152,968,246		− 36,826,789	−19.40		
Gold, fine ounces (troy).	California, Colorado, Alaska, Nevada.	4,299,784	88,884,400	$832,678,779	4,572,976	94,531,800	$649,907,108	+ 5,647,400	+ 6.35	−$182,771,671	−21.95
Silver, fine ounces (troy).	Nevada, Idaho, Montana, Utah.	66,801,500	40,348,100		72,455,100	40,067,700		− 280,400	− .69		
Lead...short tons..	Missouri, Idaho, Utah, Colorado.	411,878	36,245,264		512,794	39,997,932		+ 3,752,668	+10.35		
Zinc.....do....	Missouri, New Jersey, Montana, Colorado.	337,252	37,772,224		343,418	35,028,636		− 2,743,588	− 7.26		
Fuels:											
Coal....short tons..	Pennsylvania, West Virginia, Illinois, Ohio.	569,960,219	760,416,079		513,525,477	681,490,643		− 78,925,436	−10.38		
Petroleum..barrels..	Oklahoma, California, Illinois, West Virginia.	248,446,230	237,121,388	$1,085,384,144	265,762,535	214,125,215	989,731,382	− 22,996,173	− 9.70	−95,652,762	− 8.81
Natural gas.....	West Virginia, Pennsylvania, Ohio, Oklahoma.	.....	87,846,677		.....	94,115,524		+ 6,268,847	+ 7.14		

Structural materials:										
Clay products (brick and tile).	Ohio, Pennsylvania, Illinois, New Jersey.	.....	143,296,757	368,396,447	.....	129,588,822	337,231,768	− 13,707,935	− 9.57	− 31,164,679	− 8.46
Cement....barrels..	Pennsylvania, Indiana, California, New York.	89,541,348	89,550,527		87,257,552	80,533,203		− 9,017,324	−10.07		
Stone.....	Pennsylvania, Vermont, New York, Ohio.	.....	83,732,995		.....	77,412,292		− 6,320,703	− 7.55		
Sand and gravel, short tons.	Pennsylvania, New York, Ohio, Illinois.	79,555,849	24,217,508		79,281,735	23,846,999		− 370,509	− 1.53		
Lime...short tons..	Pennsylvania, Ohio, Wisconsin, Virginia.	3,595,390	14,648,362		3,380,928	13,247,676		− 1,400,686	− 9.56		
Gypsum.....do....	Iowa, New York, Ohio, Michigan.	2,599,508	6,774,822		2,476,465	6,895,989		+ 121,167	+ 1.79		
Slate.....	Pennsylvania, Vermont, Maine, Virginia.	.....	6,175,476		.....	5,706,787		− 468,689	− 7.59		

[a] Rank of States in metal production (except pig iron) arranged according to mines reports, not smelter output.

PRODUCTION BY STATES IN DETAIL.

The following tables arranged alphabetically by States show in detail the mineral production of the United States in the calendar years 1913 and 1914. In the report "Mineral products of the United States—review of conditions and output in 1912 and 1913," by E. W. Parker, in Mineral Resources for 1913, a brief review of the mineral industry was given for each State. As copies of that report are still available the material will not be duplicated here. Periodically in forthcoming reports it is planned to extend the earlier reviews and tables and to sketch conditions as they may change from time to time. The essential need is for the statistics, and they are given in the following tables complete. For detailed accounts of the various products the reader should consult the complete reports by subjects.

Mineral production of the United States in 1913 and 1914, by States.

Alabama.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..					(a)	(a)		
Bauxite.....long tons..	(a)	(a)			(a)	(a)		
Cement.....barrels..			823,246	$685,422			777,698	$746,555
Clay products.....short tons..	49,901	b $53,419		2,091,581	27,973	b $34,607		1,574,023
Coal.....do....	17,678,522	23,083,724			15,593,422	20,849,919		
Coke.....do....			3,323,664	b 9,627 170			3 084,149	b 8,408,443
Ferro-alloys.....long tons..							(a)(b)	(a)(b)
Gold.....fine ounces (troy)..			537	11,094			579	11,970
Graphite, crystalline.....pounds..	2,020,910	87,336			2,410,200	118,000		
Iron ore.....long tons..	5,333,218	6,648,569			4,514,926	5,727,619		
Iron, pig.....do....			1,924,762	b 23,242,374			1,661,420	b 17,481,828
Lime.....short tons..			75,468	290,394			46,966	199,814
Mica.....do....				(a)				(a)
Millstones.....do....				(a)				(a)
Mineral paints, natural pigments.....short tons..			(a)	(a)			(a)	(a)
Mineral waters.....gallons sold..	169,687	19,343			169,279	17,125		
Natural gas.....do....		(a)				(a)		
Sand and gravel.....short tons..	1,405,068	398,088			831,430	262,219		
Silver.....fine ounces (troy)..			117	71			199	110
Stone.....do....		(c)		c 1,285,944		(c)		c 1,319,753
Miscellaneous.....do....		46,618		12,361		42,382		336,325
Total value, eliminating duplications.....do....		$34,660,545				$30,879,288		

a Value included under "Miscellaneous."

b Value not included in total value.

c Stone sold rough included in derived product.

Mineral production of the United States in 1913 and 1914, by States—Continued.

Alaska.

Product.		1913				1914			
		Raw.		Derived.		Raw.		Derived.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Coal	short tons	2,072	$11,100						
Copper	pounds			21,659,958	$3,357,293			21,450,628	$2,852,934
Gems and precious stones									300
Gold	fine ounces (troy)			755,947	15,626,813			762,596	15,764,259
Gypsum	short tons	(a)			(a)	(a)			(a)
Lead	do			18	1,584				
Petroleum	barrels	(b)	(b)			(b)	(b)		
Silver	fine ounces (troy)			362,563	218,988			394,805	218,327
Stone			(b)				(b)		
Tin (metallic equivalent)	short tons			69	44,103			104	66,560
Miscellaneous			(c)		c385,617		(c)		c273,327
Total value, eliminating duplications			$19,645,498				$19,175,707		

Arizona.

Asbestos	short tons					(b)	(b)		
Cement	barrels			(b)	(b)			(b)	(b)
Clay products					$218,542				$156,167
Copper	pounds			407,923,402	63,228,127			393,017,400	52,271,314
Fluorspar	short tons	(b)	(b)						
Gems and precious stones					8,000				6,812
Gold	fine ounces (troy)			194,657	4,023,911			202,167	4,179,155
Gypsum	short tons	(b)			(b)	(b)			(b)
Lead	do			8,072	710,370			7,502	585,120
Lime	do			18,292	99,550			19,093	122,324
Mineral paints, natural pigments	do							(b)	(b)
Quicksilver	flasks			(b)	(b)			(b)	(b)
Sand and gravel	short tons	(b)	(b)			(b)	(b)		
Silica quartz	do	(b)	(b)			(b)	(b)		
Silver	fine ounces (troy)			3,948,091	2,384,647			4,377,994	2,421,031

Stone		(c)		c 107,989		(c)		c 50,251
Sulphuric acid (60° Baumé)d short tons			(b)	(b)			(b)	(b)
Tungsten ore (60 per cent concentrates) do			16	6,069			15	6,435
Zinc do			4,714	527,972			4,896	499,409
Miscellaneous		17,911		96,617		10,959		82,295
Total value, eliminating duplications		$71,429,705				$60,391,272		

Arkansas.

Bauxite long tons	(b)	(b)			195,247	$976,686		
Clay products short tons				$529,624	(b) (e)	(b) (e)		$451,986
Coal do	2,234,107	$3,923,701			1,836,540	3,158,168		
Fuller's earth do	(b)	(b)			(b)	(b)		
Gems and precious stones				6,200				640
Lead short tons			18	1,584			41	3,198
Lime do			19,391	95,846			19,230	92,067
Manganiferous ore long tons	9,650	19,250			1,970	3,940		
Mineral waters gallons sold	1,428,869	151,412			1,314,159	115,205		
Natural gas		(b)				(b)		
Oilstones								65,215
Sand and gravel short tons	821,456	320,639		(b)	789,371	325,360		
Stone		(c)		c 525,050		(c)		c 360,735
Zinc short tons			478	53,536			608	62,016
Miscellaneous		(c)		c 1,153,918		173,183		
Total value, eliminating duplications		$6,780,760				$5,785,199		

California.

Asbestos short tons					(b)	(b)		
Asphalt do	27,870	$69,825	204,228	$1,680,179	28,186	$77,810	259,972	$2,057,725
Barytes do					(b)	(b)		
Borax do	58,051	1,491,530			62,400	1,464,400		
Briquets, fuel do			(b) (e)	(b) (e)			(b) (e)	(b) (e)
Cement barrels			6,018,262	8,896,734			5,004,633	6,698,905
Chromite long tons	255	2,854			(b)	(b)		
Clay products short tons	153,871	e 167,309		5,344,958	108,543	e 139,727		4,461,661
Coal do	24,839	84,073			(b)	(b)		
Copper pounds			34,575,007	5,359,126			30,507,692	4,057,523

a Calcined in Washington State. Value included under "Miscellaneous."
b Value included under "Miscellaneous."
c Raw product included in derived product.
d From copper smelting.
e Value not included in total value.

Mineral production of the United States in 1913 and 1914, by States—Continued.

California—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Diatomaceous earth				(a)				$89,599
Feldspar, short tons	1,113	$3,838			2,778	$10,715		
Fullers' earth, do	(a)	(a)			922	6,057		
Gems and precious stones				$26,507				20,616
Gold, fine ounces (troy)			987,187	20,406,958			999,113	20,653,496
Graphite, amorphous, short tons	(a)	(a)						
Gypsum, do	49,015			230,936	27,376			184,886
Iron ore, long tons	(a)	(a)			1,282	5,128		
Iron, pig, do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lead, short tons			1,757	154,631			2,126	165,825
Lime, do			73,715	569,874			55,492	430,792
Magnesite, do	9,632	77,056			11,293	124,223		
Manganese ore, long tons					501	(a)		
Mineral paints, natural pigments, short tons			365	3,174			383	3,713
Mineral waters, gallons sold	2,801,393	531,925			2,282,569	497,923		
Natural gas		1,883,450				2,910,784		
Petroleum, barrels	97,788,525	45,709,400			99,775,327	48,066,096		
Platinum, fine ounces (troy)			368	17,802			450	20,250
Pumice, short tons					(a)	(a)		
Pyrite, long tons	70,536	218,525			71,272	235,129		
Quicksilver, flasks			15,591	627,228			11,303	554,414
Salt, barrels	(c)	(c)	c 1,082,993	c 759,485	(c)	(c)	c 1,100,443	c 856,861
Sand and gravel, short tons	1,836,012	439,009			3,900,540	777,334		
Sand-lime brick				38,839				15,387
Silica (quartz), short tons					2,435	7,803		
Silver, fine ounces (troy)			1,378,399	832,553			1,471,859	813,938
Stone		(c)		c 4,118,935		(c)		c 4,610,781
Sulphuric acid (60° Baumé) d, short tons			(a)	(a)			(a)	(a)
Talc, do	(c)	(c)	c 952	c 6,000	(c)	(c)	c 547	c 8,786
Tungsten ore (60 per cent concentrates), do			541	226,260			(a)	(a)
Zinc, do			529	59,219			195	19,863
Miscellaneous		4,880		1,209,539		51,446		1,345,761
Total value, eliminating duplications	$100,791,369				$101,087,140			

Cement	barrels			(a)	(a)		(a)	(a)
Clay products	short tons	65,579	b $70,350		$1,293,511	57,149	b $64,152	$1,143,942
Coal	do	9,232,510	14,035,090			8,170,559	13,601,718	
Coke	do			879,461	b 2,815,134		666,083	b 2,203,031
Copper	pounds			7,227,826	1,120,313		6,639,173	883,010
Ferro-alloys	long tons			(a) (b)	(a) (b)		(a) (b)	(a) (b)
Fluorspar	short tons	4,432	26,592			1,978	12,992	
Fuller's earth	do	(a)	(a)			(a)	(a)	
Gems and precious stones					2,139			1,982
Gold	fine ounces (troy)			877,857	18,146,916		961,845	19,883,105
Graphite, amorphous	short tons	(a)	(a)					
Gypsum	do	(a)			(a)	(a)		(a)
Iron ore	long tons	(a)	(a)			11,464	22,846	
Iron, pig	do			(a) (b)	(a) (b)		(a) (b)	(a) (b)
Lead	short tons			43,949	3,867,502		37,106	2,894,264
Lime	do			7,875	46,390		5,415	36,996
Manganiferous ore	long tons	49,753	5,874			39,881	13,688	
Mica					(a)			(a)
Mineral waters	gallons sold	1,053,429	89,820			968,260	113,413	
Natural gas			(a)				(a)	
Petroleum	barrels	188,799	174,779			222,773	200,894	
Sand and gravel	short tons	90,578	28,306			41,614	14,781	
Sand-lime brick					(a)			(a)
Silver	fine ounces (troy)			9,325,255	5,632,454		8,796,065	4,864,224
Stone			(c)		c 985,817		(c)	c 1,322,609
Sulphuric acid (60° Baumé) e	short tons			(a)	(a)		(a)	(a)
Tungsten ore (60 per cent concentrates)	do			953	428,760		467	182,013
Uranium and vanadium ores	do			(a)	(a)		3,518	879,345
Zinc	do			59,673	6,683,400		48,387	4,935,523
Miscellaneous			66,121		6,376,296		27,313	4,706,889
Total value, eliminating duplications			$54,294,281				$52,161,660	

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.
d From copper smelting.
e From zinc smelting.

Mineral production of the United States in 1913 and 1914, by States—Continued.

Connecticut.

Product.		1913				1914			
		Raw.		Derived.		Raw.		Derived.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products	short tons	(a) (b)	(a) (b)		$1,411,392	(a) (b)	(a) (b)		$1,238,959
Diatomaceous earth					(a)				(a)
Feldspar	short tons	20,288	$115,770			16,513	$83,291		
Gems and precious stones					200				10
Iron ore	long tons	(a)	(a)			(a)	(a)		
Iron, pig	do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lime	short tons			76,192	382,347			70,534	338,601
Mica									(a)
Mineral waters	gallons sold	2,458,327	136,878			2,341,082	134,478		
Sand and gravel	short tons	24,252	7,272			24,343	8,128		
Silica (quartz)	do	(a)	(a)			(a)	(a)		
Stone			(c)		c 1,603,663		(c)		c 1,063,184
Miscellaneous			137,589		240,536		155,960		143,691
Total value, eliminating duplications			$3,795,297				$3,023,192		

Delaware.

Clay products	short tons	11,482	b $66,647		$187,280	10,371	b $71,386		$154,718
Feldspar	do					(a)	(a)		
Mineral waters	gallons sold	(a)	(a)			(a)	(a)		
Sand and gravel	short tons	127,875	58,675			(a)	(a)		
Stone			(c)		c 289,987		(c)		c 131,086
Miscellaneous			5,600				2,712		
Total value, eliminating duplications			$541,542				$288,516		

District of Columbia.

Clay products				$160,014				[d] $148,866
Mineral waters	gallons sold	[a]	[a]		[a]	[a]		
Sand and gravel	short tons	[a]	[a]		[a]	[a]		
Sand-lime brick				[a]				[a]
Miscellaneous			[c]	[c] 86,568		31,814		39,000
Total value, eliminating duplications		$246,582			$219,680			

Florida.

Clay products	short tons	[a] [b]	[a] [b]		$253,344	[a] [b]	[a] [b]		$240,094
Diatomaceous earth					[a]				
Fuller's earth	short tons	[a]	[a]			[a]	[a]		
Lime	do			16,845	89,973			12,376	64,531
Mineral waters	gallons sold	343,123	$37,474			231,160	$24,738		
Phosphate rock	long tons	2,545,276	9,563,084			2,138,891	7,354,744		
Sand and gravel	short tons	87,061	21,194			177,241	54,120		
Sand-lime brick					79,679				105,435
Stone			[c]		[c] 207,420		[c]		[c] 343,779
Miscellaneous			[c]		[c] 384,098		434,247		
Total value, eliminating duplications		$10,508,016				$8,497,688			

Georgia.

Asbestos	short tons	1,100	$11,000			[a]	[a]		
Barytes	do	[a]	[a]			4,882	$17,747		
Bauxite	long tons	[a]	[a]			10,718	40,543		
Cement	barrels			[a]	[a]			[a]	[a]
Clay products	short tons	156,374	[b] 324,671		$2,692,619	146,374	[b] 290,814		$2,263,034
Coal	do	255,626	361,319			166,498	239,462		
Coke	do			42,747	[b] 186,304			24,517	[b] 100,529
Fuller's earth	do	[a]	[a]			[a]	[a]		
Gems and precious stones					2				
Gold	fine ounces (troy)			731	15,108			787	16,270
Graphitic shale			[a]						
Iron ore	long tons	153,336	237,876			66,222	119,363		
Lime	short tons			3,550	13,483			[a]	[a]

[a] Value included under "Miscellaneous."
[b] Value not included in total value.
[c] Raw product included under derived product.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."

Mineral production of the United States in 1913 and 1914, by States—Continued.

Georgia—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Mica								(a)
Mineral paints, natural pigments, short tons			11,869	$123,616			10,511	$86,853
Mineral waters, gallons sold	750,893	$69,442			652,566	$49,659		
Pyrite, long tons	11,110	55,094			(a)	(a)		
Sand and gravel, short tons	407,853	166,798			260,425	80,130		
Sand-lime brick				(a)				(a)
Silver, fine ounces (troy)			75	45			67	37
Slate				(a)				
Stone		(c)		c 2,105,366		(c)		c 2,238,789
Talc, short tons	(c)	(c)	(a)	(a)	(c)	(c)	(a)	(a)
Tripoli				(a)				
Miscellaneous		209,109		464,915		135,658		407,539
Total value, eliminating duplications		$6,525,792				$5,695,084		

Idaho.

Clay products, short tons	(a) (b)	(a) (b)		(a)				(a)
Coal, do	2,143	$5,149			2,267	$5,731		
Copper, pounds			9,592,966	$1,486,910			6,445,187	$857,210
Gems and precious stones				15				800
Gold, fine ounces (troy)			65,043	1,344,559			55,743	1,152,315
Iron ore, long tons	(a)	(a)			(a)	(a)		
Lead, short tons			158,936	13,986,366			174,263	13,592,517
Lime, do			4,133	22,413			(a)	(a)
Mica				(a)				(a)
Phosphate rock, long tons	(a)	(a)			(a)	(a)		
Salt, barrels			(a)	(a)			300	520
Sand and gravel, short tons	(a)	(a)			(a)	(a)		
Sand-lime brick				16,479				17,466
Silver, fine ounces (troy)			9,989,193	6,033,473			12,479,516	6,901,172

Stone		(c)		c 152,390		(c)		c 57,909
Tungsten ore (60 per cent concentrates) short tons			(a)	(a)			(a)	(a)
Zinc do			11,587	1,297,741			21,006	2,142,634
Miscellaneous		53,636		166,770		18,346		166,603
Total value, eliminating duplications		$24,565,826				$24,913,223		

Illinois.

Asphalt short tons			(a)	(a)			41,553	$340,862
Cement barrels			d 4,734,540	d $4,784,696			d 5,284,022	d 4,848,522
Clay products short tons	194,937	b $204,037		15,195,874	161,084	b $168,354		13,318,953
Coal do	61,618,744	70,313,605			57,589,197	64,693,529		
Coke do			1,859,553	b 8,503,581			1,425,168	b 5,858,700
Ferro-alloys long tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Fluorspar short tons	85,854	550,815			73,811	426,063		
Iron, pig long tons			2,892,263	b 45,796,966			1,793,714	b 24,382,458
Lead short tons			959	84,392			717	55,926
Lime do			95,977	433,331			87,603	362,727
Mineral paints, zinc and lead pigments do			(a)	(a)			(a)	(a)
Mineral waters gallons sold	1,216,442	68,549			1,760,030	81,307		
Natural gas		574,015				437,275		
Petroleum barrels	23,893,899	30,971,910			21,919,749	25,426,179		
Pyrite long tons	11,246	31,966			22,538	59,079		
Sand and gravel short tons	7,992,140	2,070,491			7,696,130	1,859,519		
Silver fine ounces (troy)			3,541	2,139			2,112	1,168
Stone		(c)		c 4,140,953		(c)		c 2,934,078
Sulphuric acid (60° Baumé) e short tons			195,145	1,303,986			243,457	1,551,876
Tripoli				128,892				59,394
Zinc short tons			2,236	250,432			4,811	490,722
Miscellaneous				1,756,126				1,272,055
Total value, eliminating duplications		$131,825,221				$117,145,108		

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.
d Exclusive of natural cement, value for which is included under "Miscellaneous."
e From zinc smelting.

Mineral production of the United States in 1913 and 1914, by States—Continued.

Indiana.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel.....short tons			(a) (b)	(a) (b)				
Cement.....barrels			c 10,219,492	c $10,218,867			9,615,827	$8,371,089
Clay products.....short tons	74,581	b $70,929		8,498,646	39,055	b $37,644		7,655,285
Coal.....do	17,165,671	19,001,881			16,641,132	18,290,928		
Coke.....do			2,727,025	b 13,182,136			2,276,652	b 9,055,937
Gems and precious stones				100				
Iron, pig.....long tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lime.....short tons			96,359	323,905			99,185	358,738
Mineral paints, natural pigments.....do			(a)	(a)			(a)	(a)
Mineral waters.....gallons sold	383,577	205,621			382,247	138,118		
Natural gas		843,047				755,407		
Oilstones				(a)				(a)
Petroleum.....barrels	956,095	1,279,226			1,335,456	1,548,042		
Pyrite.....long tons	1,242	3,115			1,710	5,281		
Sand and gravel.....short tons	5,021,878	1,260,672			6,810,706	1,267,038		
Sand-lime brick				58,550				76,175
Stone		(d)		d 4,676,689		(d)		d 4,136,132
Sulphuric acid (60° Baumé) e.....short tons			(a)	(a)			(a)	(a)
Miscellaneous				20,761,060				15,317,466
Total value, eliminating duplications		$46,502,633				$42,864,267		

Iowa.

Cement.....barrels			3,455,800	$3,972,876			4,224,076	$4,008,915
Clay products.....short tons	2,655	b $1,900		5,573,681	10,750	b $4,250		6,401,745
Coal.....do	7,525,936	13,496,710			7,451,022	13,364,070		
Gypsum.....do	456,031			1,157,939	480,404			1,321,457
Lead.....do			65	5,720				
Lime.....do			10,015	47,520			(a)	(a)
Mineral paints, natural pigments.....do			(a)	(a)			(a)	(a)
Mineral waters.....gallons sold	48,665	7,369			303,827	30,179		

Natural gas		120				200		
Sand and gravel	short tons	2,698,032	528,066			2,253,254	556,868		
Sand-lime brick					(a)				(a)
Stone			(d)		d 805,294		(d)		d 538,681
Miscellaneous					6,720				65,000
Total value, eliminating duplications			$25,602,015				$26,287,115		

Kansas.

Cement	barrels			c 3,291,818	c $3,286,861			c 3,237,906	c $2,643,415
Clay products					f 1,919,910				f 1,905,961
Coal	short tons	7,202,210	$12,036,292			6,860,988	$11,238,253		
Gems and precious stones					30				
Gypsum	short tons	110,510			308,308	80,774			278,343
Lead	do			2,427	213,576			1,409	109,902
Lime	do			(a)	(a)				
Mineral paints, zinc and lead pigments	do			(a)	(a)			(a)	(a)
Mineral waters	gallons sold	337,193	60,026			272,722	56,440		
Natural gas			3,288,394				3,340,025		
Petroleum	barrels	2,375,029	2,248,283			3,103,585	2,433,074		
Pumice	short tons	(a)	(a)			(a)	(a)		
Salt	barrels	1,351,721	235,552	1,346,358	624,852	1,548,286	279,730	1,419,578	644,820
Sand and gravel	short tons	1,119,990	271,509			1,347,394	381,065		
Sand-lime brick					(a)				
Stone			(d)		d 825,607		(d)		d 600,576
Sulphuric acid (60°Baumé) e	short tons			(a)	(a)			(a)	(a)
Zinc	do			10,088	1,129,856			11,284	1,150,968
Miscellaneous			(d)		d 863,507		(d)		d 803,779
Total value, eliminating duplications			$27,312,563				$25,866,351		

Kentucky.

Asphalt	short tons	(a)	(a)			(a)	(a)		
Barytes	do					(a)	(a)		
Cement	barrels			(a)	(a)			(a)	(a)
Clay products	short tons	91,114	b $113,871		$2,914,276	66,229	b $91,837		$2,376,406
Coal	do	19,616,690	20,516,749			20,382,763	20,852,463		

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of natural cement, value for which is included under "Miscellaneous."
d Raw product included in derived product.
e From zinc smelting.
f Exclusive of pottery, value for which in included under "Miscellaneous."

Mineral production of the United States in 1913 and 1914, by States—Continued.

Kentucky—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Coke.....short tons			317,084	[a] $753,897			443,959	[a] $971,060
Ferro-alloys.....long tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Fluorspar.....short tons	19,622	$113,903			19,077	$128,986		
Iron ore.....long tons	(b)	(b)			(b)	(b)		
Iron, pig.....do			59,071	[a] 950,484			57,687	[a] 706,120
Lead.....short tons			22	1,936			16	1,248
Lime.....do			6,001	24,313			5,978	26,762
Mineral waters.....gallons sold	475,675	53,334			437,334	56,494		
Natural gas		509,846				490,875		
Oilstones				(b)				(b)
Petroleum.....barrels	524,568	675,748			502,441	498,556		
Sand and gravel.....short tons	1,137,286	424,049			1,563,498	539,335		
Sand-lime brick				(b)				(b)
Stone		(c)		[c] 1,150,205		(c)		[c] 1,257,722
Zinc.....short tons			327	36,624			230	23,460
Miscellaneous		43,850		1,035,229		57,300		804,005
Total value, eliminating duplications		$26,845,579				$26,668,474		

Louisiana.

Asphalt.....short tons							(b)	(b)
Clay products				[d] $638,491				[d] $422,062
Mineral waters.....gallons sold	700,795	$39,657			576,138	$31,562		
Natural gas		(b)				(b)		
Petroleum.....barrels	12,498,828	12,255,931			14,309,435	12,886,897		
Salt.....do	(b)	(b)			(b)	(b)		
Sand and gravel.....short tons	878,943	262,840			1,051,930	284,297		
Stone		(c)		(b)		(c)		(b)
Sulphur.....long tons	(b)	(b)			(b)	(b)		
Miscellaneous		7,726,757		88,152		8,192,864		72,343
Total value, eliminating duplications		$21,011,828				$21,890,025		

Maine.

Clay products				$666,573				[d] $914,808
Feldspar	short tons	38,248	$347,499		30,063	$194,560		
Gems and precious stones				820				3,865
Lime	short tons			146,970	906,604		122,218	512,842
Mica								[b]
Mineral waters	gallons sold	1,174,262	368,436		1,082,631	333,234		
Sand and gravel	short tons	48,963	23,575		[b]	[b]		
Silica (quartz)	do				[b]	[b]		
Slate				323,998				277,419
Stone			[c]	[c] 1,792,079		[c]		[c] 1,723,032
Miscellaneous						11,600		4,530
Total value, eliminating duplications			$4,429,584			$3,975,890		

Maryland.

Briquets, fuel	short tons			[a] [b]	[a] [b]		[a] [b]	[a] [b]
Cement	barrels			[b]	[b]		[b]	[b]
Chromite	long tons					[b]		
Clay products	short tons	24,829	[a] $36,955		$1,917,500	29,755	[a] $43,498	$1,846,500
Coal	do	4,779,839	5,927,046			4,133,547	5,234,796	
Coke	do			[a] [b]	[a] [b]		[a] [b]	[a] [b]
Copper	pounds						[b]	[b]
Diatomaceous earth					[b]			[b]
Feldspar	short tons	16,702	82,833			5,909	19,434	
Gold	fine ounces (troy)						11	225
Iron ore	long tons	[b]	[b]			749	1,817	
Iron, pig	do			[a] [b]	[a] [b]		[a] [b]	[a] [b]
Lime	short tons			108,883	357,392		115,845	390,298
Mica								[b]
Mineral paints, natural pigments	short tons			[b]	[b]		[b]	[b]
Mineral waters	gallons sold	1,390,437	126,883			1,691,776	124,403	
Sand and gravel	short tons	1,821,214	622,567			1,571,124	523,720	
Silica (quartz)	do	7,858	55,442			12,057	67,634	
Silver	fine ounces (troy)						44	24
Slate					83,993			77,391
Soapstone	short tons	[c]	[c]	[b]	[b]		[b]	[b]
Stone			[c]		[c] 1,153,115		[c]	[c] 1,110,506
Miscellaneous			[c]		[c] 6,605,212		[c]	[c] 3,991,973
Total value, eliminating duplications			$11,292,723			$10,587,564		

[a] Value not included in total value.
[b] Value included under "Miscellaneous."
[c] Raw product included in derived product.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."

Mineral production of the United States in 1913 and 1914, by States—Continued.

Massachusetts.

Product.		1913				1914			
		Raw.		Derived.		Raw.		Derived.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products	short tons	843	[a] $1,807		$1,814,875	1,181	[a] $2,742		$1,681,557
Coke	do			[a] [b]	[a] [b]			[a] [b]	[a] [b]
Diatomaceous earth									[b]
Fuller's earth	short tons	[b]	[b]			[b]	[b]		
Gems and precious stones									400
Iron ore	long tons	[b]	[b]			[b]	[b]		
Iron, pig	do			[a] [b]	[a] [b]			[a] [b]	[a] [b]
Lime	short tons			130,365	683,541			124,199	652,067
Mineral waters	gallons sold	3,907,395	213,802			3,084,385	174,324		
Sand and gravel	short tons	290,757	149,036			645,773	287,218		
Sand-lime brick					42,149				28,713
Silica (quartz)	short tons	[b]	[b]			[b]	[b]		
Stone			[c]		[c] 4,096,372		[c]		[c] 3,438,556
Talc	short tons			[b]	[b]			[b]	[b]
Miscellaneous			35,254		1,849,758		23,927		1,760,712
Total value, eliminating duplications			$7,044,529				$6,292,833		

Michigan.

Briquets, fuel	short tons			[a] [b]	[a] [b]			[a] [b]	[a] [b]
Bromine	pounds			[b]	[b]			[b]	[b]
Calcium chloride	short tons			[b]	[b]			[b]	[b]
Cement	barrels			4,081,281	$4,228,879			4,218,429	$4,064,781
Clay products	short tons	1,710	[a] $6,504		2,674,125	1,463	[a] $4,572		2,700,066
Coal	do	1,231,786	2,455,227			1,283,030	2,559,786		
Coke	do			[a] [b]	[a] [b]			[a] [b]	[a] [b]
Copper	pounds			135,853,409	21,057,278			164,344.058	21,857,759
Gems and precious stones					400				300
Grindstones									
Gypsum	short tons	423,896			721,325	393,006			[b] 705,841

Iron ore.....long tons..	12,668,560	33,479,954			8,533,280	18,722,358		
Iron, pig.....do....			447,188	[a] 6,568,920			379,619	[a] 5,229,948
Lime.....short tons..			77,088	331,852			66,507	287,648
Manganiferous ore.....long tons..	[d] 377,468	(d)			[d] 192,909	(d)		
Mineral paints, natural pigments.....short tons..			(b)	(b)			(b)	(b)
Mineral waters.....gallons sold..	884,893	52,642			931,343	70,310		
Natural gas.....		1,405				1,442		
Petroleum.....barrels..	(b)	(b)			(b)	(b)		
Salt.....do....	(c)	(c)	[c] 11,528,800	[c] 3,293,032	(c)	(c)	[c] 11,670,976	[c] 3,299,005
Sand and gravel.....short tons..	6,424,168	1,529,142			3,757,979	1,143,771		
Sand-lime brick.....				321,245				255,784
Scythestones.....				(b)				(b)
Silica (quartz).....short tons..	(b)	(b)			(b)	(b)		
Silver.....fine ounces (troy)..			295,173	178,284			413,500	228,665
Stone.....		(c)		[c] 1,520,133		(c)		[c] 1,500,910
Miscellaneous.....		18,363		2,341,884		19,091		2,497,837
Total value, eliminating duplications.....		$72,143,211				$57,732,447		

Minnesota.

Cement.....barrels..			(b)	(b)			(b)	(b)
Clay products.....short tons..	(a) (b)	(a) (b)		[e] $1,781,017	(a) (b)	(a) (b)		[e] $1,944,886
Coke.....do....			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Feldspar.....do....	(b)	(b)						
Iron ore.....long tons..	36,603,331	$80,789,025			23,298,547	$40,628,771		
Iron, pig.....do....			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lime.....short tons..			22,800	112,300			22,057	104,195
Manganiferous ore.....long tons..	(d)	(d)			55,192	(b)		
Mineral waters.....gallons sold..	4,802,053	183,759			5,639,232	194,041		
Sand and gravel.....short tons..	2,094,910	282,882			1,074,436	417,979		
Sand-lime brick.....				129,164				119,271
Stone.....		(c)		[c] 1,952,686		(c)		[c] 1,513,039
Miscellaneous.....		30,800		1,783,810		225,216		1,590,027
Total value, eliminating duplications.....		$85,814,533				$45,680,865		

[a] Value not included in total value.
[b] Value included under "Miscellaneous."
[c] Raw product included in derived product.
[d] Quantity and value included in iron ore.
[e] Exclusive of pottery, value for which is included under "Miscellaneous."

Mineral production of the United States in 1913 and 1914, by States—Continued.

Mississippi.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.....short tons	(a) (b)	(a) (b)		$641,271	(a) (b)	(a) (b)		$530,857
Gems and precious stones								21
Iron ore.....long tons					(a)	(a)		
Iron, pig.....do							(a) (b)	(a) (b)
Mineral waters.....gallons sold	346,652	$81,800			415,904	$73,068		
Sand and gravel.....short tons	1,891,663	420,401			2,144,267	499,726		
Miscellaneous		14				(c)		c 3,750
Total value, eliminating duplications		$1,143,472				$1,104,197		

Missouri.

Barytes.....short tons	31,131	$117,638			33,317	$112,231		
Briquets, fuel.....do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Cement.....barrels			4,485,820	$4,556,822			4,706,389	$4,485,744
Clay products.....short tons	238,032	b 470,277		6,602,076	209,181	b 463,703		6,077,284
Coal.....do	4,318,125	7,468,308			3,935,980	6,802,325		
Copper.....pounds			576,204	89,312			44,463	5,914
Gems and precious stones								8
Iron ore.....long tons	37,134	83,628			36,304	75,696		
Iron, pig.....do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lead.....short tons			176,116	15,498,208			192,612	15,023,736
Lime.....do			161,770	734,009			155,680	686,051
Mineral paints:								
Natural pigments.....do							(a)	(a)
Zinc and lead pigments.....do			(a)	(a)			(a)	(a)
Mineral waters.....gallons sold	697,467	84,316			583,288	74,793		
Natural gas		6,795				5,319		
Petroleum.....barrels	(a)	(a)			(a)	(a)		
Pyrite.....long tons	(a)	(a)			(a)	(a)		
Sand and gravel.....short tons	4,126,126	1,109,233			3,528,678	1,020,903		
Silver.....fine ounces (troy)			35,620	21,514			61,168	33,826
Stone		(c)		c 2,538,699		(c)		c 2,294,103

Tripoli				83,995				81,434
Zinc	short tons		124,963	13,995,856			105,994	10,811,388
Miscellaneous		20,679		1,347,839		16,768		1,327,506
Total value, eliminating duplications		$54,001,088				$48,597,593		
Montana.								
Cement	barrels		(a)	(a)			(a)	(a)
Clay products	short tons	3,410	[b] $3,314		2,978	[b] $9,648		[d] $440,519
Coal	do	3,240,973	5,653,539		2,805,173	4,913,191		
Copper	pounds			287,828,699	44,613,448		233,229,640	31,019,542
Gems and precious stones					244,935			67,452
Gold	fine ounces (troy)			168,995	3,493,432		199,204	4,117,911
Graphite, crystalline	pounds				(a)	(a)		
Gypsum	short tons	(a)			(a)	(a)		(a)
Iron ore	long tons	2,475	7,425			(a)		
Lead	short tons			5,468	481,176		4,828	376,584
Lime	do			(a)	(a)		(a)	(a)
Mineral waters	gallons sold	180,200	3,246			100,700	5,555	
Sand and gravel	short tons	15,856	7,857			17,864	17,075	
Silver	fine ounces (troy)			13,819,201	8,346,797		12,016,460	6,645,102
Stone			(c)		[c] 343,516		(c)	[c] 242,030
Zinc	short tons			44,337	4,965,693		55,790	5,690,608
Miscellaneous					689,095	8,581		700,739
Total value, eliminating duplications		$69,307,056				$54,244,889		
Nebraska.								
Cement	barrels						(a)	(a)
Clay products	short tons				[d] $886,166	(a) (b)	(a) (b)	[d] $640,955
Gems and precious stones								8
Mineral waters	gallons sold	105,985	$10,599			10,900	$1,490	
Pumice	short tons	(a)	(a)			(a)	(a)	
Sand and gravel	do	832,909	149,286			859,962	141,319	
Sand-lime brick					(a)			(a)
Stone			(c)		[c] 327,187		(c)	[c] 303,680
Miscellaneous			(c)		[c] 60,480		58,372	21 663
Total value, eliminating duplications		$1,433,718				$1,166,787		

[a] Value included under "Miscellaneous."
[b] Value not included in total value.
[c] Raw product included under derived product.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."

Mineral production of the United States in 1913 and 1914, by States—Continued.

Nevada.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				(a)				(a)
Coal, short tons	(a)	(a)			(a)	(a)		
Copper, pounds			90,693,751	$14,057,531			60,986,450	$8,111,198
Diatomaceous earth				(a)				(a)
Gems and precious stones				13,405				8,584
Gold, fine ounces (troy)			570,589	11,795,130			555,402	11,481,188
Graphite, amorphous, short tons	(a)	(a)			(a)	(a)		
Gypsum, do	(a)			(a)	(a)			(a)
Iron ore, long tons	(a)	(a)			(a)	(a)		
Lead, short tons			8,172	719,137			6,405	499,577
Lime, do			(a)	(a)			(a)	(a)
Mineral waters, gallons sold	4,897	$1,584			221,942	$3,191		
Platinum and palladium, fine ounces (troy)							278	12,342
Quicksilver, flasks			1,645	66,178			2,089	102,465
Salt, barrels			8,971	7,947	(b)	(b)	b 4,436	b 2,448
Sand and gravel, short tons	14,905	3,729			(a)	(a)		
Silver, fine ounces (troy)			16,090,083	9,718,410			15,455,491	8,546,887
Sulphur, long tons					(a)	(a)		
Tungsten ore (60 per cent concentrates), short tons			(a)	(a)				
Zinc, do			7,210	807,502			6,490	661,992
Miscellaneous		158,568		492,963		97,095		457,371
Total value, eliminating duplications		$37,842,084				$29,984,338		

New Hampshire.

Clay products				c $462,534				c $398,066
Feldspar, short tons					(a)	(a)		
Fluorspar, do	(a)	(a)			(a)	(a)		
Garnet, abrasive, do	(a)	(a)			(a)	(a)		
Gems and precious stones				665				615
Mica				79,671				47,837

Mineral waters	gallons sold	402,355	$12,707			194,418	$11,731		
Sand and gravel	short tons	252,000	87,500			670,000	112,500		
Scythestones					(a)				(a)
Stone			(b)		b 1,482,771		(b)		b $1,383,325
Zinc	short tons			15	1,680			6	635
Miscellaneous			4,927		86,470		12,840		62,286
Total value, eliminating duplications			$2,218,925				$2,029,835		

New Jersey.

Briquets, fuel	short tons			(a) (d)	(a) (d)			(a) (d)	(a) (d)
Cement	barrels			4,255,015	$3,638,755			3,530,476	$3,081,205
Clay products	short tons	448,135	d $769,689		19,705,378	373,703	d $648,584		16,484,652
Coke	do			255,792	d 695,041			255,283	d 680,972
Greensand marl	do	314	223			992	760		
Iron ore	long tons	291,653	980,303			346,820	1,076,208		
Iron, pig	do			(a) (d)	(a) (d)			(a) (d)	(a) (d)
Lime	short tons			14,378	55,775			10,953	41,226
Manganiferous zinc residuum e	long tons	102,239	306,717			100,198	300,594		
Mineral paints, natural pigments	short tons			(a)	(a)				
Mineral waters	gallons sold	2,067,277	188,546			1,710,030	155,649		
Sand and gravel	short tons	3,896,421	1,162,050			4,665,677	1,544,322		
Sand-lime brick					15,757				(a)
Slate					(a)				(a)
Stone			(b)		b 1,772,832		(b)		b 1,533,668
Talc	short tons	(b)	(b)	(a)	(a)	(a)	(a)		
Zinc	do			72,156	8,081,503			74,253	7,515,914
Miscellaneous					1,616,355		(b)		b 1,525,265
Total value, eliminating duplications			$35,931,191				$31,756,503		

New Mexico.

Clay products	short tons	3,513	d $9,906		$176,528	2,042	d $4,695		$205,914
Coal	do	3,708,806	5,401,260			3,877,689	6,230,871		
Coke	do			467,945	d 1,548,536			362,572	d 1,228,045
Copper	pounds			56,308,706	8,727,850			59,307,925	7,887,954
Flourspar	short tons	(a)	(a)						
Gems and precious stones					3,350				55

a Value included under "Miscellaneous."
b Raw product included in derived product.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Value not included in total value.
e Ore mined in New Jersey; smelted in Pennsylvania.

Mineral production of the United States in 1913 and 1914, by States—Continued.

New Mexico—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces (troy)..			42,663	$881,926			56,681	$1,171,696
Gypsum.....short tons..	43,180			102,564	(a)			(a)
Iron ore.....long tons..	164,085	$148,405			(a)	(a)		
Lead.....short tons..			1,973	173,640			882	68,782
Lime.....do....			1,246	8,612			(a)	(a)
Mica.....				(a)				(a)
Mineral waters.....gallons sold..	154,800	16,730			41,000	$6,600		
Petroleum.....barrels..	(a)	(a)						
Salt.....do....			(a)	(a)			(a)	(a)
Sand and gravel.....short tons..	(a)	(a)			(a)	(a)		
Silver.....fine ounces (troy)..			1,631,273	985,289			1,777,445	982,927
Stone.....		(b)		b 219,566		(b)		b 418,305
Tungsten ore (60 per cent concentrates).....short tons..			(a)	(a)			(a)	(a)
Zinc.....do....			8,262	925,297			9,202	938,573
Miscellaneous.....		62,427		28,925		84,272		76,970
Total value, eliminating duplications.....		$17,862,369				$18,072,919		

New York.

Abrasives, artificial.....pounds..			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Aluminum.....do....			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Briquets, fuel.....short tons..			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Cement.....barrels..			5,354,129	$4,918,119			5,713,383	$5,143,401
Clay products.....short tons..	5,518	c $9,568		11,469,476	5,640	c $7,286		9,078,933
Coke.....do....			758,486	c 3,301,400			457,370	c 1,726,133
Diatomaceous earth.....				(a)				(a)
Emery.....short tons..	957	4,785			485	2,425		
Feldspar.....do....	22,750	119,060			19,579	102,027		
Ferro-alloys.....long tons..			(a) (c)	(a) (c)				
Garnet, abrasive.....short tons..	4,990	173,695			4,026	139,670		
Graphite:								
Crystalline.....pounds..	(a)	(a)			(a)	(a)		
Artificial.....do....			13,633,342	c 973,397			10,455,139	c 698,800

Gypsum	short tons	529,627			1,280,699	523,368			1,237,192
Iron ore	long tons	1,420,889	3,100,235			640,252	1,992,892		
Iron, pig	do			1,967,449	c 30,203,673			1,357,575	c 19,353,309
Lime	short tons			114,071	503,157			94,009	396,494
Mica					(a)				
Millstones					21,987				16,748
Mineral paints, natural pigments	short tons			16,002	39,891			16,025	37,739
Mineral waters	gallons sold	9,801,255	871,601			8,201,202	672,913		
Natural gas			2,425,633				2,600,352		
Petroleum	barrels	948,191	2,284,307			938,974	1,760,868		
Pyrite	long tons	(a)	(a)			(a)	(a)		
Salt	barrels	(b)	(b)	b 10,780,514	b 2,865,187	(b)	(b)	b 10,389,314	b 2,824,733
Sand and gravel	short tons	8,624,093	2,963,663			7,070,820	2,250,169		
Sand-lime brick					136,013				107,633
Silica (quartz)	short tons	(a)	(a)						
Slate					144,882				112,776
Stone			(b)		b 7,185,493		(b)		b 6,575,079
Talc, fibrous	short tons			81,705	788,500			86,075	821,286
Miscellaneous			406,904		11,771,475		425,934		11,000,996
Total value, eliminating duplications			$41,709,002				$36,307,036		

North Carolina.

Barytes	short tons	(a)	(a)			(a)	(a)		
Clay products	do	16,352	c $139,644		$1,614,406	17,773	c $164,837		$1,460,790
Copper	pounds							20,434	2,718
Feldspar	short tons	(a)	(a)			15,420	43,153		
Garnet, abrasive	do	(a)	(a)						
Gems and precious stones					849				3,070
Gold	fine ounces (troy)			6,117	126,448			6,344	131,141
Iron ore	long tons	(a)	(a)			(a)	(a)		
Lime	short tons			9,815	47,838			8,098	36,356
Mica					267,913				195,270
Millstones					8,772				5,164
Mineral waters	gallons sold	176,068	23,877			158,226	21,964		
Sand and gravel	short tons	400,577	127,574			492,092	72,989		
Silica (quartz)	do	(a)	(a)			(a)	(a)		
Silver	fine ounces (troy)			1,812	1,095			1,524	843
Stone			(b)		b 1,212,501		(b)		b 1,407,671
Talc and soapstone	short tons	412	921	4,264	47,896	300	600	898	27,813
Zinc	do			10	1,142				
Miscellaneous			258,464				109,703		
Total value, eliminating duplications			$3,739,696				$3,519,245		

a Value included under "Miscellaneous."
b Raw product included in derived product.
c Value not included in total value.

Mineral production of the United States in 1913 and 1914, by States—Continued.

North Dakota.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel.....short tons							(a) (b)	(a) (b)
Clay products.....do	(a) (b)	(a) (b)		$262,580	(a) (b)	(a) (b)		$266,046
Coal.....do	495,320	$750,652			506,685	$771,379		
Mineral waters.....gallons sold	582,356	14,403			408,000	8,150		
Natural gas		(a)				(a)		
Sand and gravel.....short tons	17,226	10,589			23,210	11,325		
Sand-lime brick				(a)				(a)
Miscellaneous		(c)		c 18,060		3,584		15,994
Total value, eliminating duplications	$1,055,676				$1,063,540			

Ohio.

Bromine.....pounds			(a)	(a)			(a)	(a)
Calcium chloride.....short tons			(a)	(a)			4,044	$22,789
Cement.....barrels			1,671,919	$1,757,413			1,951,472	1,942,927
Clay products.....short tons	384,325	b $277,455		38,388,296	324,333	b $247,356		37,166,768
Coal.....do	36,200,527	39,948,058			18,843,115	21,250,642		
Coke.....do			351,846	b 1,231,554			521,638	b 1,678,686
Ferro-alloys.....long tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Grindstones and pulpstones				737,572				606,001
Gypsum.....short tons	254,863			695,149	265,091			773,413
Iron ore.....long tons	8,299	17,100			(a)	(a)		
Iron, pig.....do			6,913,961	b 103,824,517			5,226,925	b 70,331,114
Lime.....short tons			497,693	1,976,316			480,010	1,880,836
Mineral waters.....gallons sold	3,317,639	125,084			3,558,413	145,586		
Natural gas		10,521,930				14,667,790		
Oilstones and scythestones				(a)				11,582
Petroleum.....barrels	8,781,468	17,538,452			8,536,352	13,372,729		
Pyrite.....long tons	13,622	34,998			7,279	19,718		
Salt.....barrels			5,310,135	1,318,156			5,482,836	1,320,554
Sand and gravel.....short tons	5,605,767	2,092,401			5,510,879	2,157,131		
Sand-lime brick				(a)				(a)

Stone		(c)		c 6,261,338		(c)		c 5,655,713
Sulphuric acid (60° Baumé) d	short tons		(a)	(a)			(a)	(a)
Miscellaneous				487,129		(c)		c 1,124,528
Total value, eliminating duplications		$121,795,892			$101,661,384			

Oklahoma.

Asphalt	short tons	16,459	$91,416	9,975	$136,405	9,669	$73,535	(a)
Cement	barrels			(a)	(a)			(a)
Clay products					573,371			$786,314
Coal	short tons	4,165,770	8,542,748			3,988,613	8,204,015	
Gypsum	do	147,876			330,416	113,103		312,856
Lead	do			6,228	548,064			589,368
Lime	do			2,640	12,160			11,130
Mineral waters	gallons sold	502,439	26,231			804,675	26,936	
Natural gas			7,436,389				8,050,039	
Petroleum	barrels	63,579,384	59,581,948			73,631,724	57,253,187	
Salt	do			(a)	(a)			(a)
Sand and gravel	short tons	157,628	39,457			1,477,618	713,117	
Sand-lime brick					(a)			(a)
Silver	fine ounces (troy)			1,300	785			6,187
Stone			(c)		c 278,600		(c)	
Tripoli								(a)
Zinc	short tons			11,664	1,306,308			13,992
Miscellaneous					1,264,462			
Total value, eliminating duplications		$80,168,820			$78,744,447			

								(a)
Briquets, fuel	short tons			(a) (b)	(a) (b)			(a) (b)
Clay products	do	(a) (b)	(a) (b)		c $771,795	(a) (b)	(a) (b)	
Coal	do	46,063	$116,724			51,558	$143,556	
Copper	pounds			43,330	6,716			39,248
Gems and precious stones					2,975			1,600
Gold	fine ounces (troy)			78,740	1,627,710			76,987
Gypsum	short tons	(a)			(a)	(a)		
Lead	do			44	3,837			8
Lime	do			4,747	30,704			3,143

								c 560,271

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included under derived product.
d From zinc smelting.
e Exclusive of pottery, value for which is included under "Miscellaneous."

Mineral production of the United States in 1913 and 1914, by States—Continued.

Oregon—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Mineral waters.....gallons sold..	68,413	$19,409			57,800	$12,810		
Platinum.....fine ounces (troy)..			16	$675			75	$3,375
Sand and gravel.....short tons..	1,442,152	432,938			1,271,362	390,177		
Silver.....fine ounces (troy)..			179,036	108,139			142,552	78,831
Stone.....		(a)		a 357,498		(a)		a 435,066
Miscellaneous.....		(a)		a 181,200		(a)		a 231,230
Total value, eliminating duplications.....		$3,563,919				$3,331,132		

Pennsylvania.

Abrasives, artificial.....pounds..			(b) (c)	(b) (c)			(b) (c)	(b) (c)
Briquets, fuel.....short tons..			21,917	c $79,179			92,137	c $228,097
Bromine.....pounds..			(b)	(b)			(b)	(b)
Calcium chloride.....short tons..			(b)	(b)			(b)	(b)
Cement.....barrels..			d 28,060,495	d 24,268,800			26,061,332	20,977,055
Clay products.....short tons..	479,548	c $836,916		24,231,482	376,637	c $715,458		21,846,936
Coal:								
Anthracite.....do....	91,524,022	195,181,127			90,821,507	188,181,399		
Bituminous.....do....	173,781,217	193,039,806			147,983,294	159,006,296		
Coke.....do....			28,753,444	c 67,920,864			20,258,393	c 42,447,886
Copper.....pounds..			503,792	78,088			(b)	(b)
Feldspar.....short tons..	9,629	75,851			10,101	71,393		
Ferro-alloys.....long tons..			212,719	c 10,939,453			149,342	c 6,519,636
Gems and precious stones.....				1				
Graphite, crystalline.....pounds..	393,817	19,242			(b)	(b)		
Iron ore.....long tons..	478,693	589,038			400,062	339,639		
Iron, pig.....do....			12,871,349	c 197,726,314			9,267,197	c 127,686,331
Lime.....short tons..			852,927	2,743,197			849,963	2,740,238
Mica.....				(b)				
Millstones.....				(b)				(b)

Mineral paints:								
Natural pigments short tons			33,304	293,257			30,761	285,635
Zinc and lead pigments do			(b)	(b)			(b)	(b)
Mineral waters gallons sold	2,163,931	190,459			2,457,626	213,752		
Natural gas		21,695,845				20,401,295		
Oilstones								(b)
Petroleum barrels	7,917,302	19,690,502			8,170,335	15,573,822		
Salt do			(b)	(b)			(b)	(b)
Sand and gravel short tons	6,702,449	3,381,692			6,866,077	2,937,957		
Sand-lime brick				73,674				54,418
Silica (quartz) short tons	(b)	(b)			(b)	(b)		
Slate				3,733,581				3,609,959
Stone		(a)		a 10,117,469		(a)		a 8,153,413
Sulphuric acid (60° Baumé) e short tons			(b)	(b)			(b)	(b)
Talc do			(b)	(b)			(b)	(b)
Tripoli				(b)				(b)
Miscellaneous		(a)		a 6,995,398		17,430		7,950,388
Total value, eliminating duplications		$506,341,809				$452,374,085		

Rhode Island.

Clay products				(b)				(b)
Graphite, amorphous short tons	(b)	(b)			(b)	(b)		
Lime do			(b)	(b)			(b)	(b)
Mineral waters gallons sold	444,036	$28,535			438,702	$29,639		
Sand and gravel short tons					(b)	(b)		
Soapstone do	(b)	(b)			(b)	(b)	(b)	(b)
Stone		(a)		a $643,995		(a)		a $625,276
Miscellaneous		8,841		132,581		6,540		116,261
Total value, eliminating duplications		$813,952				$777,716		

South Carolina.

Barytes short tons	(b)	(b)			(b)	(b)		
Clay products do	32,222	c $124,249		$583,241	28,421	c $133,047		$568,645
Fuller's earth do	(b)	(b)						
Gems and precious stones				20				5
Gold fine ounces (troy)			236	4,881			356	7,360
Lime short tons			(b)	(b)			(b)	(b)
Manganese ore long tons					410	(b)		

a Raw product included in derived product.
b Value included under "Miscellaneous."
c Value not included in total value.
d Exclusive of natural cement and Puzzolan, value for which is included under "Miscellaneous."
e From zinc smelting.

Mineral production of the United States in 1913 and 1914, by States—Continued.

South Carolina—Continued

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Mica				(a)				(a)
Mineral waters.....gallons sold	261,412	$49,199			293,949	$48,071		
Phosphate rock.....long tons	109,333	440,588			106,919	415,039		
Sand and gravel.....short tons	39,730	4,958			33,788	8,480		
Silver.....fine ounces (troy)			40	$24			33	$18
Stone		(b)		b 360,476		(b)		b 357,657
Tin.....short tons			3	1,936				
Miscellaneous		2,460		16,367		2,130		6,889
Total value, eliminating duplications	$1,464,150				$1,414,294			

South Dakota.

Clay products				$46,685				$57,711
Coal.....short tons	10,540	$20,648			11,850	$20,456		
Copper.....pounds			1,793	278				
Gems and precious stones				162				404
Gold.....fine ounces (troy)			354,071	7,319,294			354,758	7,333,508
Gypsum.....short tons	(a)			(a)	(a)			(a)
Lead.....do			5	449			2	152
Lime.....do			4,217	28,610			5,603	36,976
Lithium.....do	(a)	(a)			(a)	(a)		
Mica				12,609				(a)
Mineral waters.....gallons sold	(a)	(a)			145,647	8,999		
Natural gas		(a)				(a)		
Sand and gravel.....short tons	1,068,833	89,306			232,395	40,215		
Sand-lime brick				(a)				27,665
Silica (quartz).....short tons					(a)	(a)		
Silver.....fine ounces (troy)			172,702	104,312			176,642	97,683
Stone		(b)		b 172,736		(b)		b 156,907
Tin.....short tons			1	660				

Tungsten ore (60 per cent concentrates)...do...			(a)	(a)				
Miscellaneous		46,211		67,099		32,780		48,145
Total value, eliminating duplications		$7,909,059				$7,861,601		

Tennessee.

Aluminum...pounds..							(a) (c)	(a) (c)
Barytes...short tons..	2,098	$3,568			8,913	$14,341		
Bauxite...long tons..	(a)	(a)			(a)	(a)		
Cement...barrels..			(a)	(a)			(a)	(a)
Clay products...short tons..	56,304	c 124,572		$1,493,085	62,861	c 129,976		$1,546,315
Coal...do....	6,860,184	7,839,721			5,943,258	6,776,573		
Coke...do...			364,578	c 925,430			264,127	c 642,573
Copper...pounds..			19,390,750	3,005,566			18,737,656	2,492,108
Ferro-alloys...long tons..			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Gold...fine ounces (troy)..			367	7,595			300	6,194
Iron ore...long tons..	364,092	493,556			330,214	466,523		
Iron, pig...do....			270,481	c 3,576,485			178,481	c 2,150,452
Lime...short tons..			92,427	288,400			85,939	266,881
Mineral paints, natural pigments...do...			(a)	(a)			(a)	(a)
Mineral waters...gallons sold..	1,088,034	64,905			943,502	56,741		
Natural gas...		600				300		
Phosphate rock...long tons..	451,559	1,774,392			483,203	1,822,770		
Sand and gravel...short tons..	828,633	288,900			1,097,720	400,182		
Silica (quartz)...do....	(a)	(a)			(a)	(a)		
Silver...fine ounces (troy)..			108,105	65,295			97,402	53,864
Stone...		(b)		b 2,062,686		(b)		b 1,932,462
Sulphuric acid (60° Baumé) d...short tons..			(a)	(a)			(a)	(a)
Tripoli...				(a)				
Zinc...short tons..			5,583	625,296			10,425	1,063,350
Miscellaneous		73,148		3,152,907		73,702		4,936,043
Total value, eliminating duplications		$21,008,938				$19,645,213		

Texas.

Asphalt...short tons..	(a)	(a)	122,026	$1,970,354	(a)	(a)	57,934	$608,132
Cement...barrels..			2,108,737	2,663,063			2,096,140	2,686,653
Clay products...short tons..	2,746	c $9,465		3,049,349	2,362	c $9,616		2,280,987
Coal...do....	2,429,144	4,288,920			2,323,773	3,922,459		
Copper...pounds..			34,665	5,373			23,760	3,160
Fuller's earth...short tons..					(a)	(a)		

a Value included under "Miscellaneous."
b Stone sold rough included in derived product.
c Value not included in total value.
d From copper smelting.

Mineral production of the United States in 1913 and 1914, by States—Continued.

Texas—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gems and precious stones				$344				$1,725
Gold.....fine ounces (troy)			16	340			11	234
Gypsum.....short tons	161,090			345,749	158,814			490,937
Iron ore.....long tons	(a)	(a)						
Lead.....short tons			113	9,910			75	5,812
Lime.....do			45,897	255,893			37,365	200,788
Mineral waters.....gallons sold	1,187,612	$132,488			766,597	$93,014		
Natural gas		2,073,823				2,469,770		
Petroleum.....barrels	15,009,478	14,675,593			20,068,184	14,942,848		
Quicksilver.....flasks			(a)	(a)			(a)	(a)
Salt.....barrels			355,529	278,008			334,979	251,493
Sand and gravel.....short tons	870,943	455,908			1,681,379	638,026		
Sand-lime brick				(a)				(a)
Silver.....fine ounces (troy)			427,553	258,242			530,817	293,542
Stone		(b)		b 725,106		(b)		b 870,224
Sulphur.....long tons	(a)	(a)			(a)	(a)		
Zinc.....short tons			326	36,546			108	11,039
Miscellaneous		267,137		174,764		384,972		207,611
Total value, eliminating duplications	$31,666,910				$30,363,426			

Utah.

Asphalt.....short tons	30,810	$529,341			20,798	$412,980		
Cement.....barrels			950,469	$1,233,421			974,723	$1,317,575
Clay products.....short tons	4,969	c 11,708		d 708,906	5,837	c 13,961		d 676,142
Coal.....do	3,254,828	5,384,127			3,103,036	4,935,454		
Coke.....do			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Copper.....pounds			161,445,962	25,024,124			152,034,002	20,220,522
Gems and precious stones				7,505				5,023
Gold.....fine ounces (troy)			172,468	3,565,229			157,961	3,265,347
Gypsum.....short tons	(a)			(a)	44,950			184,621

Iron ore	long tons	14,690	44,628			(a)	(a)	
Lead	short tons			83,063	7,309,579			85,662	6,681,602
Lime	do			8,680	56,704			12,425	74,212
Mineral waters	gallons sold	(a)	(a)			(a)	(a)		
Pumice	short tons	(a)	(a)						
Salt	barrels	29,721	12,370	300,722	179,316	42,414	16,662	333,043	214,850
Sand and gravel	short tons	108,758	16,481			235,856	59,628		
Silver	fine ounces (troy)			13,084,835	7,903,240			11,154,916	6,168,669
Slate									(a)
Stone			(b)		b 415,471		(b)		b 498,819
Tungsten ore (60 per cent concentrates)	short tons							(a)	(a)
Uranium and vanadium	do			(a)	(a)			776	61,955
Zinc	do			9,429	1,056,038			7,995	815,453
Miscellaneous			3,968		1,576,702		10,672		1,459,065
Total value, eliminating duplications			$53,606,520				$45,624,698		

Vermont.

Clay products	short tons	(a) (c)	(a) (c)		$94,773	4,976	c $33,701		$75,847
Copper	pounds			13,900	2,155				
Feldspar	short tons	(a)	(a)						
Gold	fine ounces (troy)				3				
Lime	short tons			32,803	171,138			28,758	142,034
Mineral paints, natural pigments	do			(a)	(a)			(a)	(a)
Mineral waters	gallons sold	17,725	$7,068			51,151	8,600		
Sand and gravel	short tons	116,765	15,045			108,359	11,538		
Scythestones					(a)				(a)
Silver	fine ounces (troy)			105	63				
Slate					1,697,820				1,414,247
Stone			(b)		b 7,313,355		(b)		b 6,635,477
Talc and soapstone	short tons			45,547	327,375			50,698	363,465
Miscellaneous			36,892		18,401				14,659
Total value, eliminating duplications			$9,647,985				$8,665,867		

Virginia.

Asbestos	short tons					(a)	(a)		
Barytes	do	(a)	(a)			(a)	(a)		
Briquets, fuel	do			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Cement	barrels			(a)	(a)			(a)	(a)

a Value included under "Miscellaneous."
b Stone sold rough included in derived product.
c Value not included in total value.
d Exclusive of pottery, value for which is included under "Miscellaneous."

Mineral production of the United States in 1913 and 1914, by States—Continued.

Virginia—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.....short tons..	2,789	[a] $2,484	.....	[b] $1,705,651	2,177	[a] $2,722	.....	[b] $1,472,348
Coal.....do....	8,828,068	8,952,653	.....	.....	7,959,535	8,032,448	.....	.....
Coke.....do....	.....	.....	1,303,603	[a] 2,840,275	.....	.....	780,984	[a] 1,582,419
Copper.....pounds..	.....	.....	56,287	8,724	.....	.....	139,008	18,488
Diatomaceous earth.....	.....	.....	.....	[c]	.....	.....	.....	.....
Feldspar.....short tons..	.....	.....	.....	.....	[c]	[c]	.....	.....
Gems and precious stones.....	.....	.....	.....	30	.....	.....	.....	.....
Gold.....fine ounces (troy)..	.....	.....	29	604	.....	.....	21	429
Gypsum.....short tons..	[c]	.....	.....	[c]	[c]	.....	.....	[c]
Iron ore.....long tons..	492,649	983,279	.....	.....	346,382	719,415	.....	.....
Iron, pig.....do....	.....	.....	380,508	[a] 5,310,167	.....	.....	197,981	[a] 2,481,197
Lead.....short tons..	.....	.....	816	71,808	.....	.....	127	9,906
Lime.....do....	.....	.....	236,665	805,443	.....	.....	243,990	763,775
Manganese and manganiferous ore.....long tons..	[d] 4,048	[d] 40,480	.....	.....	2,946	23,089	.....	.....
Mica.....	.....	.....	.....	5,150	.....	.....	.....	24,653
Millstones.....	.....	.....	.....	23,530	.....	.....	.....	20,100
Mineral paints:								
Natural pigments.....short tons..	.....	.....	1,513	12,008	.....	.....	[c]	[c]
Zinc and lead pigments.....do....	.....	.....	[c]	[c]	.....	.....	.....	.....
Mineral waters.....gallons sold..	2,873,288	298,473	.....	.....	2,906,976	293,512	.....	.....
Pyrite.....long tons..	148,259	587,041	.....	.....	141,276	556,091	.....	.....
Salt.....barrels..	.....	.....	[c]	[c]	.....	.....	[c]	[c]
Sand and gravel.....short tons..	787,009	239,591	.....	.....	639,382	229,595	.....	.....
Silver.....fine ounces (troy)..	.....	.....	960	580	.....	.....	1,458	806
Slate.....	.....	.....	.....	175,830	.....	.....	.....	204,139
Stone.....	.....	[e]	.....	[e] 1,063,782	.....	[e]	.....	[e] 2,152,378
Talc and soapstone.....short tons..	[e]	[e]	[e] 26,487	[e] 615,558	571	1,852	21,116	526,086
Titanium minerals:								
Ilmenite.....do....	.....	.....	.....	.....	.....	.....	89	4,895
Rutile.....do....	.....	.....	305	49,000	.....	.....	94	11,280
Zinc.....do....	.....	.....	2,719	304,528	.....	.....	174	17,748
Miscellaneous.....	.....	[e]	.....	[e] 1,274,837	.....	102,735	.....	1,234,579
Total value, eliminating duplications.....	$17,178,580				$16,400,347			

Washington.

Briquets, fuel.....short tons			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Cement.....barrels			2,023,172	$2,853,260			2,045,465	$2,303,433
Clay products.....short tons	2,028	a $8,837		b 2,390,226	691	a $3,829		b 1,809,491
Coal.....do	3,877,891	9,243,137			3,064,820	6,751,511		
Coke.....do			76,221	a 432,770			84,923	a 472,531
Copper.....pounds			954,081	147,883			778,728	103,571
Diatomaceous earth				(c)				(c)
Gems and precious stones				500				
Gold.....fine ounces (troy)			33,682	696,275			26,953	557,173
Lead.....short tons			101	8,909			33	2,555
Lime.....do			28,070	178,945			29,430	189,260
Mineral paints, natural pigments.....do			(c)	(c)			(c)	(c)
Mineral waters.....gallons sold	150,498	18,834			180,787	28,777		
Sand and gravel.....short tons	1,301,771	385,886			1,178,330	324,628		
Sand-lime brick				(c)				(c)
Silver.....fine ounces (troy)			331,239	200,068			264,861	146,468
Stone		(e)		e 1,399,475		(e)		e 1,600,615
Tungsten ore (60 per cent concentrates).....short tons			(c)	(c)				
Miscellaneous				92,345				78,926
Total value, eliminating duplications		$17,579,743				$13,830,739		

West Virginia.

Bromine.....pounds			(c)	(c)			(c)	(c)
Calcium chloride.....short tons			(c)	(c)			(c)	(c)
Cement.....barrels			(c)	(c)			(c)	(c)
Clay products.....short tons	77,171	a $65,239		$5,208,270	67,265	a $53,545		$5,761,411
Coal.....do	71,254,136	71,822,804			71,707,626	71,391,408		
Coke.....do			2,472,752	a 5,504,416			1,427,962	a 2,847,284
Grindstones				(e)				(c)
Iron ore.....long tons	(c)	(c)			(c)	(c)		
Iron, pig.....do			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Lime.....short tons			232,683	789,901			192,195	680,065
Mineral waters.....gallons sold	316,749	52,259			307,890	49,129		
Natural gas		34,164,850				35,515,329		
Petroleum.....barrels	11,567,299	28,828,814			9,680,033	18,468,540		
Salt.....do			113,921	63,803			145,429	78,036
Sand and gravel.....short tons	1,026,960	939,933			1,106,742	590,391		

a Value not included in total value.
b Exclusive of pottery, value for which is included under "Miscellaneous."
c Value included under "Miscellaneous."
d Manganese ore alone.
e Raw product included in derived product.

Mineral production of the United States in 1913 and 1914, by States—Continued.

West Virginia—Continued.

Product.	1913				1914			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Silica (quartz) ..... short tons					(a)	(a)		
Stone		(b)		b $1,193,323		(b)		b $921,208
Miscellaneous		(b)		b 4,202,852		$51,020		2,386,980
Total value, eliminating duplications		$143,591,272				$134,071,803		

Wisconsin.

Briquets, fuel ..... short tons			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Clay products ..... do	742	c $1,286		$1,020,728	646	c $1,149		$950,999
Coke ..... do			(a) (c)	(a) (c)			(a) (c)	(a) (c)
Copper ..... pounds							10,300	1,370
Graphite, amorphous ..... short tons	(a)	(a)			(a)	(a)		
Iron ore ..... long tons	896,243	2,149,397			591,595	1,178,610		
Iron, pig ..... do			292,793	c 4,430,117			250,944	c 3,350,199
Lead ..... short tons			1,806	164,208			1,494	116,532
Lime ..... do			243,006	1,005,496			227,469	871,820
Manganiferous ore ..... long tons	d 209,075	(d)			d 154,653	(d)		
Mineral paints:								
Natural pigments ..... short tons			2,144	11,584			2,339	8,389
Zinc and lead pigments ..... do			(a)	(a)			(a)	(a)
Mineral waters ..... gallons sold	6,326,533	872,518			5,145,452	588,373		
Pyrite ..... long tons	25,328	94,727			14,188	78,460		
Sand and gravel ..... short tons	4,044,754	772,125			3,594,336	768,996		
Sand-lime brick				77,564				86,682
Silica (quartz) ..... short tons	(a)	(a)			(a)	(a)		
Silver ..... fine ounces (troy)							16	9
Stone		(b)		b 2,157,980		(b)		b 2,413,435
Zinc ..... short tons			30,110	3,372,320			31,113	3,173,526
Miscellaneous		60,943		3,750,390		59,187		3,662,193
Total value, eliminating duplications		$12,452,480				$11,022,643		

Wyoming.

Clay products	short tons	(a) (c)	(a) (c)		$61,678	(a) (c)	(a) (c)		$64,942
Coal	do	7,393,066	$11,510,045			6,475,293	$10,033,747		
Copper	pounds			385,239	59,712			17,421	2,317
Gems and precious stones					300				356
Gold	fine ounces (troy)			1,170	24,184			242	5,006
Gypsum	short tons	30,632			74,862	31,216			86,196
Iron ore	long tons	(a)	(a)			(a)	(a)		
Lime	short tons			13	168				
Mineral waters	gallons sold	16,200	3,610			69,658	8,802		
Natural gas			(a)				(a)		
Petroleum	barrels	2,406,522	1,187,232			3,560,375	1,679,192		
Phosphate rock	long tons	(a)	(a)			(a)	(a)		
Sand and gravel	short tons	771,139	63,577			718,914	48,595		
Silver	fine ounces (troy)			957	578			116	64
Stone			(b)		b 109,784		(b)		b 62,331
Sulphur	long tons	(a)	(a)			(a)	(a)		
Miscellaneous			587,969				427,764		
Total value, eliminating duplications			$13,682,091				$12,417,752		

a Value included under "Miscellaneous."
b Raw product included in derived product.
c Value not included in total value.
d Tonnage and value included in iron ore.

PREFATORY NOTE TO THE GENERAL AND MINES REPORTS ON GOLD, SILVER, COPPER, LEAD, AND ZINC.

By H. D. McCaskey.

In the mining industry five metals are closely related in both the genesis and the geologic occurrence of their ores; they also hold together in mining and in metallurgical treatment. They are gold, silver, copper, lead, and zinc. Of their ores, some contain all five metals, many contain three or four, and few contain only one. Gold and silver, for instance, on the one hand, and lead and zinc, on the other, almost always stand in close genetic relations, and the ores of each two are usually mined together. Copper ores almost invariably produce some silver and gold as well as copper, and lead ores, with certain exceptions, produce notable supplies of silver. Zinc ores in the Western States contribute also to the silver production. In the same mines sometimes, and in the same mining district frequently, all five metals occur in commercial quantity.

This situation is recognized by the United States Geological Survey in its publication of the annual reports on the mineral resources of the country; hence the general treatment of each of the five metals in the general reports and the grouping together of the related metals in the various mines reports descriptive of individual or geographically grouped States.

To facilitate advance publication, the complete report upon these five metals is therefore divided into sixteen sections, each of which is published separately. The first four sections give figures of output for the calendar year in marketable form for the metals named as obtained from the smelters, refineries, and mints, and general reviews of the respective industries for the entire country; the last twelve sections give the production as obtained from the mines so far as possible in terms of recoverable metal in ores and other material sold or treated during the calendar year and supply information in detail relative to the mining industry in the respective States, counties, and mining districts. The figures given in the general reports are the final official statistics of production for the country and of the States. The general report on gold and silver includes the statistics of recovered precious metals as determined jointly by the Bureau of the Mint and the United States Geological Survey.

The sixteen sections, which appear as separate chapters in this volume, are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Gold, silver, copper, lead, and zinc in the Eastern States (mines report).
Silver, copper, lead, and zinc in the Central States (mines report).
Gold, silver, and copper in Alaska (mines report).
Gold, silver, copper, lead, and zinc in Arizona (mines report).
Gold, silver, copper, lead, and zinc in California and Oregon (mines report).
Gold, silver, copper, lead, and zinc in Colorado (mines report).
Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
Gold, silver, copper, lead, and zinc in Montana (mines report).
Gold, silver, copper, lead, and zinc in Nevada (mines report).
Gold, silver, copper, lead, and zinc in New Mexico and Texas (mines report).
Gold, silver, copper, and lead in South Dakota and Wyoming (mines report).
Gold, silver, copper, lead, and zinc in Utah (mines report).

In measurement of ores, concentrates, and similar material the short ton of 2,000 pounds is used throughout. The ore classification is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals. The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and also precious-metal-bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The copper ores include those carrying over 2½ per cent of copper, or even less in the cases of the great disseminated copper deposits of the West and of the copper ores of the Lake Superior region. In general, the lead ores are those containing over 4½ per cent of lead, and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious-metal content; but some ores of lower grade in lead, and especially in zinc, are treated profitably for these metals, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of the ones enumerated.

The price per unit of metal production (gold excepted, which is fixed by law at $20.67+ per fine ounce) is based upon averages of daily market prices current at New York for silver, copper, and lead, and at St. Louis for metallic zinc or spelter. The prices used by the United States Geological Survey for calculation of values for the years 1850–1914, inclusive, are as follows:

Prices of silver, copper, lead, and zinc, 1850–1914.

Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]	Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]
	Fine ounce.	*Pound.*	*Pound.*	*Pound.*		*Fine ounce.*	*Pound.*	*Pound.*	*Pound.*
1850	$1.32	$0.22	$0.05	.....	1883	$1.11	$0.165	$0.043	$0.045
1851	1.34	.166	.05	.....	1884	1.11	.13	.037	.044
1852	1.33	.22	.05	.....	1885	1.07	.108	.039	.043
1853	1.35	.22	.06	$0.055	1886	.99	.111	.046	.044
1854	1.35	.22	.06	.....	1887	.98	.138	.045	.046
1855	1.34	.27	.07	.....	1888	.94	.168	.044	.049
1856	1.34	.27	.066	.....	1889	.94	.135	.039	.05
1857	1.35	.25	.06	.....	1890	1.05	.156	.045	.055
1858	1.34	.23	.06	.....	1891	.99	.128	.043	.05
1859	1.36	.22	.055	.....	1892	.87	.116	.04	.046
1860	1.35	.23	.056	.....	1893	.78	.108	.037	.04
1861	1.33	.22	.05	.....	1894	.63	.095	.033	.035
1862	1.35	.22	.06	.....	1895	.65	.107	.032	.036
1863	1.345	.34	.06	.....	1896	.68	.108	.03	.039
1864	1.345	.47	.07	.139	1897	.60	.12	.036	.041
1865	1.337	.393	.066	.....	1898	.59	.124	.038	.046
1866	1.339	.343	.07	.....	1899	.60	.171	.045	.058
1867	1.33	.254	.065	.....	1900	.62	.166	.044	.044
1868	1.326	.23	.065	.....	1901	.60	.167	.043	.041
1869	1.325	.243	.06	.....	1902	.53	.122	.041	.048
1870	1.328	.212	.06	.....	1903	.54	.137	.042	.054
1871	1.325	.211	.06	.....	1904	.58	.128	.043	.051
1872	1.322	.356	.064	.....	1905	.61	.156	.047	.059
1873	1.297	.280	.06	.....	1906	.68	.193	.057	.061
1874	1.278	.220	.06	.....	1907	.66	.20	.053	.059
1875	1.24	.227	.058	.07	1908	.53	.132	.042	.047
1876	1.16	.21	.061	.072	1909	.52	.13	.043	.054
1877	1.20	.19	.055	.06	1910	.54	.127	.044	.054
1878	1.15	.166	.036	.049	1911	.53	.125	.045	.057
1879	1.12	.186	.041	.052	1912	.615	.165	.045	.069
1880	1.15	.214	.05	.055	1913	.604	.155	.044	.056
1881	1.13	.182	.048	.052	1914	.553	.133	.039	.051
1882	1.14	.181	.049	.053					

[a] Report of the Director of the Mint, pp. 212–213, 1914. Equivalent value of fine ounce based on average price and average rate of exchange.

[b] Weed, W. H., Copper handbook, vol. 11, pp. 1339, 1343, for years 1850–1903. By computation from data for years 1850–1860, p. 1339. Computation for electrolytic copper since 1904.

[c] New York price, Ingalls, W. R., Lead and zinc in the United States, p. 203, 1908. U. S. Geological Survey since 1904.

[d] New York price, 1875–1904, Ingalls, W. R., Lead and zinc in the United States, p. 342, 1908. St. Louis price, U. S. Geological Survey since 1904. Oral communication from C. E. Siebenthal for 1853 and 1864.

It is to be understood, of course, that full market values are not received by producers for metals in ore and intermediate products, nor always for metals in marketable form, that payment is made in accordance with contracts for treatment or sale, and that, therefore, average daily quotations do not necessarily agree with average prices received.

Each of the sixteen sections mentioned is published in a separate pamphlet for advance distribution, and copies can be obtained, as long as the supply lasts, on request made to the Director, United States Geological Survey, Washington, D. C.

MINERAL RESOURCES OF THE UNITED STATES FOR 1914—PART I.

CHROMIC IRON ORE.

By J. S. Diller.

PRODUCTION.

The increased marketed production of chromic iron ore in 1914 is noteworthy. The output sold was 591 long tons in 1914, valued at $8,715, as compared with 255 long tons in 1913, valued at $2,854, a gain in 1914 of nearly 132 per cent in quantity and of more than 205 per cent in value. The great increase in value in 1914 was due in part to the rise in price per ton.

Almost the entire annual output has come from Shasta County, Cal. A large production has been reported in several other counties of California, but inquiry has disclosed the fact that the output reported did not consist of ore actually removed from the ground and sold, but was merely a rough estimate of ore in sight in partly developed prospects.

A small output of chromite sand was reported in 1914 from several points near Baltimore, Md., where many years ago the chromic iron-ore industry of the United States began its development. Baltimore still remains the chief manufacturing center for chrome chemical products, although the production of ore, after thriving from its discovery in 1828 until 1850, ceased soon after that time because of foreign competition. Chromic iron ore imported from Europe then took the place of the domestic material and has ever since been the controlling factor in the chromite market on the Atlantic coast.

Chromic iron ore was discovered in the early fifties in California, which has been for many years practically the only producing State. There was a small production in Wyoming in 1908 and 1909 and in Maryland in 1914. The following table shows the quantity, value, and price per ton of the chromic iron ore produced and marketed in the United States since 1880.

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Production of chromic iron ore in the United States, 1880–1914, in long tons.

Year.	Quantity.	Value.	Price per ton.	Year.	Quantity.	Value.	Price per ton.
1880	2,288	$27,808	$12.15	1898	.....	.....	.....
1881	2,000	30,000	15.00	1899	.....	.....	.....
1882	2,500	50,000	20.00	1900	140	$1,400	$10.00
1883	3,000	60,000	20.00	1901	368	5,790	15.73
1884	2,000	35,000	17.50	1902	315	4,567	14.50
1885	2,700	40,000	14.81	1903	150	2,250	15.00
1886	2,000	30,000	15.00	1904	123	1,845	15.00
1887	3,000	40,000	13.33	1905	22	375	17.05
1888	1,500	20,000	13.33	1906	107	1,800	16.82
1889	2,000	30,000	15.00	1907	290	5,640	19.45
1890	3,599	53,985	15.00	1908	359	7,230	20.14
1891	1,372	20,580	15.00	1909	598	8,300	13.88
1892	1,500	25,000	16.60	1910	205	2,729	13.31
1893	1,450	21,750	15.00	1911	120	1,629	13.58
1894	3,680	53,231	14.40	1912	201	2,753	13.70
1895	1,740	16,795	9.69	1913	255	2,854	11.19
1896	786	6,667	8.40	1914	591	8,715	14.75
1897	.....	.....	.....				

If the increased demand continues, other deposits are likely to be opened. The largest annual production of the United States was 3,680 long tons in 1894. This maximum was followed by a rapid decline, so that the production of 591 long tons in 1914 exceeds that of any year since 1896 except 1909.

WORLD'S PRODUCTION.

The world's production of chromic iron ore for the last few years is given by countries in the following table. The output of the United States is relatively small as compared with the production of New Caledonia, Rhodesia, and Russia. Complete figures are not available for the production of 1913.

World's production of chromic iron ore, 1907–1913, in long tons.

Country.	[a] 1907	[a] 1908	[a] 1909	[a] 1910	[a] 1911	[a] 1912	1913
United States	290	359	598	205	120	201	255
Bosnia and Herzegovina	305	492	327	315	246	197	.....
Canada	6,425	6,451	2,205	267	[b] 140	.....	.....
Greece	11,545	4,281	9,448	9,311	4,542	6,209	.....
India	7,274	4,745	9,250	1,737	3,804	2,890	.....
Japan	(c)	(c)	(c)	2,091	1,500	1,591	.....
New Caledonia	3,739	15,550	33,368	33,368	34,447	41,325	[d] 62,352
New South Wales	30	.....	.....	.....	.....	23	.....
Rhodesia	8,017	11,927	22,875	33,287	46,753	61,840	[d] 62,365
Russia	25,940	10,777	21,857	14,157	(c)	[e] 20,934	.....
Sweden	.....	.....	.....	31	.....	(c)	.....
Turkey	[f] 21,111	28,394	11,364	(c)	(c)	145	.....

[a] Statistics taken from Mines and Quarries: General report with statistics, pt. 4, London.
[b] Canada Dept. Mines Ann. Rept., 1912, p. 180, Ottawa, 1914.
[c] Statistics not available.
[d] Mineral Industry, 1913.
[e] Mining Journal, London, Aug. 9, 1913, p. 754.
[f] Export figures.

PRICES.

The large supplies of foreign chromic iron ore permit its delivery in American ports at low rates. It is sold on the basis of 50 per cent content of chromic oxide, and a fair price prior to 1914 for cargo purchases was from $14.50 to $15.50 a ton. Chromic oxide in excess of 50 per cent is sold at the rate of 50 to 60 cents per additional unit.

In California the price is said to vary from $10 to $17 a long ton, with recent quotations at $15 a ton f. o. b. at shipping point. The average price per long ton of the marketed production of the United States in 1913 was $11.19, but in 1914 the average selling price increased to $14.75. Under this average price is included also the chrome sand of Baltimore, which is used abroad for making special colors and which commands a higher price than any other chromic iron ore because of its cost of production.

The price of the chromate and bichromate of potash imported in 1913 averaged 8.1 cents a pound and that of chromic acid 14.9 cents a pound. Early in 1915 American manufacturers quoted bichromate of potash at 15 to 15¼ cents a pound and bichromate of soda at 4¾ to 5½ cents a pound. The restrictions on the importation of chrome ore has not yet materially affected the price of bichromates, but it may be expected to do so if long continued. The abnormally high price of bichromate of potash is due to the great advance in the price of muriate of potash. Chromate of soda is quoted at 6 cents a pound.

The market price of chrome brick, standard sizes, in carload lots, January 1, 1914, was, on the Atlantic seaboard, $135 a thousand; but at the close of the year the price had greatly advanced on account of the difficulty in importing the chromic iron ore necessary for the manufacture of the brick.

IMPORTS.

For the calendar year 1914 only total quantities and values of imports for consumption are available, but greater details of imports are available for the fiscal year ending June 30, 1914. The imports for the calendar year will therefore be given first, to be followed by the detail of imports for the fiscal year.

Chromic iron ore, chromic acid, and chromates of potash imported and entered for consumption in the United States in calendar years 1908 to 1914, inclusive.

Year.	Chromic iron ore.		Chromic acid.		Chromate and bichromate of potash.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Pounds.*		*Pounds.*		
1908	27,876	$345,960	3,805	$708	216,081	$15,453	$362,121
1909	39,624	460,758	7,559	1,412	537,017	28,837	491,007
1910	38,579	415,768	9,850	1,635	406,790	19,569	436,972
1911	37,540	407,958	6,789	1,349	22,408	2,159	411,466
1912	53,929	499,818	8,728	1,376	32,913	3,085	504,279
1913	65,180	622,821	5,562	1,100	18,629	1,819	625,740
1914	80,736	695,645	9,164	1,597	31,858	2,375	699,617

In 1914 the imports of chromic iron ore amounted to 80,736 long tons, valued at $695,645, an increase of 15,556 tons in quantity and of $72,824 in value. The imports of chromic acid and of chromates were much greater in quantity and value than in 1913, notwithstanding the restrictions on exports of chromite from Rhodesia, New Caledonia, and some other foreign sources.

During the fiscal year ending June 30, 1914, the United States imported chromic iron ore from seven countries, as against five countries reported in 1913. The following table shows the quantity and value imported from each country in 1913 and 1914. The largest supply comes by way of Portuguese Africa from Rhodesia; the countries next in rank are New Caledonia and Turkey in Asia. During the later part of 1914 all shipments from these sources were cut off.

Imports of chromic iron ore, by countries, fiscal years ending June 30, 1913 and 1914, in long tons.[a]

Country.	1913			1914		
	Quantity.	Value.	Price per ton.	Quantity.	Value.	Price per ton.
Canada				533	$9,283	$17.41
England				58	717	12.36
Greece				8,450	87,931	10.40
Japan	322	$2,712	$8.42			
Netherlands						
New Caledonia	6,620	47,913	7.24	25,970	166,915	6.42
Portugal	5,000	60,831	12.17			
Portuguese Africa	24,000	291,981	12.17	30,001	364,989	12.16
Turkey in Asia	13,830	100,227	7.25	14,830	107,292	7.23
Total	49,772	503,664	10.12	79,842	737,127	9.23

[a] Commerce and Navigation: U. S. Dept. Commerce, 1914.

The small shipment of chromic iron ore from Japan to the United States in 1913 was not continued in 1914. On the other hand, there were three new sources not noted in 1913—Canada, England, and Greece.

The preceding table shows clearly the source of the chromic iron ore used in the United States, and the following table shows the ports through which it enters the United States. More than half of it comes in at Baltimore and none at Pacific ports.

Ports of entry of imports of chromic iron ore in fiscal year ending June 30, 1914, in long tons.

Port.	Quantity.	Value.	Price per ton.
Buffalo	533	$9,283	$17.41
Baltimore	44,721	457,462	10.22
New York	17,308	114,580	6.62
Philadelphia	23,280	195,223	8.31
Massachusetts	50	618	12.36
Total	85,892	777,166	9.05

Imports of chromium compounds for fiscal year ending June 30, 1914.[a]

	Quantity.	Value.	Price per unit.
Chromic iron ore, long tons	85,892	$77,166	$9.05
Chromic acid, pounds	7,160	1,064	.149
Chromate and bichromate of potash, pounds	34,866	2,822	.081
Chromate and bichromate of soda, pounds	11,056	542	.049
Chrome and ferrochrome, $200 or less a ton, long tons	50	3,855	77.10
Chrome and ferrochrome, more than $200 a ton, long tons	2	1,584	792.00

[a] Summary of imports for consumption for fiscal year ending June 30, 1914, Tables 15 and 16: U. S. Dept. Commerce, 1914.

The following table shows the imports of chromium and ferrochrome in 1912, 1913, and 1914, in long tons:

Imports of chrome or chromium and ferrochrome in calendar years 1912, 1913, and 1914, in long tons.

	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Valued at $200 and less a ton	436	$47,179	307	$51,415	200	$21,553
Valued at more than $200 a ton	38	30,408				

MINERALS AND USES OF CHROMIUM.

Chromium minerals.—Although a number of minerals contain chromium, practically only one—chromic iron ore or chromite—is a commercial source of chromium. The chemical composition of chromite is expressed by the formula FeO, Cr_2O_3 in the proportion of 32 per cent ferrous oxide (FeO) and 68 per cent chromic oxide (Cr_2O_3). Chromite is a common constituent of basic intrusive rocks, such as peridotites and pyroxenites, and especially of serpentine derived from them, and all the commercial bodies of chromic iron ore occur in these rocks.

Uses.—The demand for chromic iron ore arises chiefly from its use in making refractory chrome bricks and furnace lining; in making alloys—such as ferrochrome and the like—used in manufacturing steel for cutting tools, projectiles, and armor plate; in a great chemical industry which produces many colors and dyes; and in tanning. Its application for all these purposes is increasing, and the demand for it is steadily growing.

CHROMIC IRON ORE IN NORTH AMERICA.

OCCURRENCE.

The locations of the most valuable deposits of chromic iron ore in North America are shown on the accompanying map. These deposits occur in Maryland, Pennsylvania, North Carolina, Wyoming, California, Alaska, Canada, and Cuba, and the map shows their relation

to lines of transportation by water and by rail. As the bulk of the country's supply is on the Pacific coast and the greatest demand for

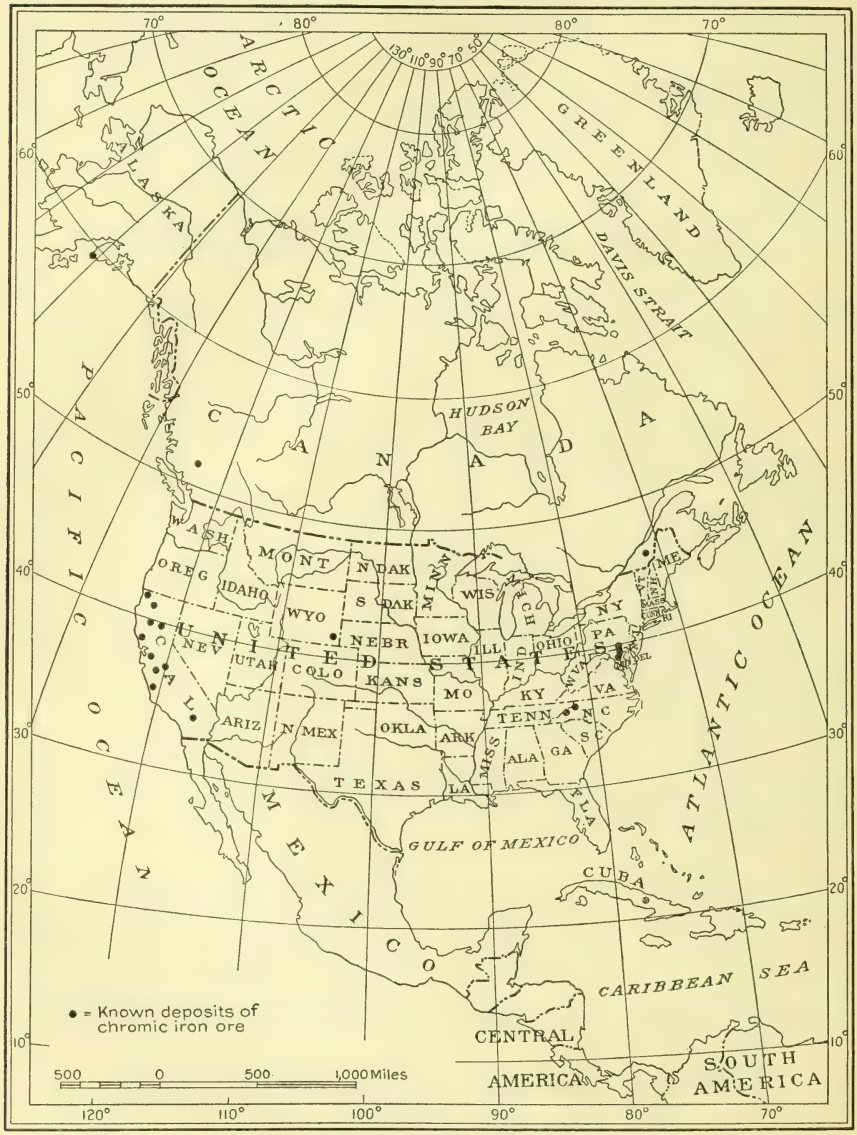

FIGURE 1.—Map of North America showing known deposits of chromic iron ore.

it is on the Atlantic coast, the Panama Canal may play an increasingly important part in the exchange of ore and manufactured product.

CALIFORNIA.

DEPOSITS AND PRODUCTION.

California contains much chromic iron ore, which occurs generally in small grains but in many places also in irregular bodies of sufficient size to be of economic importance. It is scattered through the serpentine and closely related intrusive rocks of the Coast Range and the Sierra Nevada. Bodies of chromic iron ore occur in at least 25 counties of the State, of which Alameda, Fresno, Glenn, San Luis Obispo, Shasta, and Tehama contain the most important deposits, although Butte, Calaveras, Del Norte, Mendocino, Placer, San Benito, Sierra, Siskiyou, and Trinity also contain considerable bodies.

Deposits were discovered in the serpentine of California in the early fifties,[1] and the Tyson Mining Co., of Baltimore, Md., acquired properties in Del Norte County about 1860 or earlier. In 1865 the Geological Survey of California, under Whitney, noted deposits of chromite in Del Norte and Tuolumne counties, and especially near the southwestern border of Fresno County, a few miles from the New Idria quicksilver mines, at which place Whitney describes[2] a block of chromite projecting from the serpentine to a height of 4 feet, a length of 7 feet 4 inches, and a width of 5 feet 6 inches. This body of ore was at first mistaken for silver ore, and attempts were made to mine it as such. About 40 tons of ore were mined and piled on the dump.

Notwithstanding the discovery of chromic iron ore in California, practically the entire supply used in the United States was imported for about 20 years—1860 to 1880; but, finally, about 1880, active production began in California and has continued, chiefly in response to local demand, until the present time, with an average annual output of 1,205 long tons and a total output of about 41,000 long tons, at an average price of nearly $14 a ton. For the last six years the average annual domestic production (sales) has been only 328 long tons, while the quantity demanded for actual use, as shown by the average annual import for consumption plus the marketed production during the same period, has been 52,926 long tons a year.

The chief problem in supplying California chromite to eastern manufacturers is the matter of transcontinental transportation, but the opening of the Panama Canal will in large measure obviate that difficulty, while the cutting off of the foreign supply by the European war must greatly increase the demand for domestic ore.

ALAMEDA COUNTY.

The Cedar Mountain mine, 14 miles southeast of Livermore, in Alameda County, was operated prior to 1894, and several thousand tons of ore was shipped to Philadelphia.[3] Other prospects have been opened in the same region, but in recent years only a few tons have been shipped and most of it from the dump. Some of the old workings are still open to a depth of 30 feet, and the drift faces show some ore.

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[1] California State Min. Bur. Bull. 38, p. 269, 1906.
[2] California Geol. Survey, vol. 1, p. 59, 1865.
[3] California State Min. Bur. Bull. 38, p. 267, 1906, and Samuel H. Dolbear, Mining Press [Min. and Sci. Press], Mar. 6, 1915, p. 358.

CALAVERAS COUNTY.

The geology of a large part of Calaveras County is well known,[1] and years ago bodies of chromic iron ore in the serpentine about 5 miles north of Valley Springs and about 7 miles northeast of Milton were marked on the economic sheet of the Jackson folio. These localities were prospected, and some ore is reported to have been produced. Recently a much larger production has been reported, but complete information is not available.

FRESNO COUNTY.

Nine miles north of Piedra, the terminal point of a branch of the Santa Fe Railway in Fresno County, about 50 tons of chromic iron ore has been mined and furnished to the near-by Copper King smelter and also to the Fresno Copper Co. smelter, besides the shipment of 60 tons by wagon 20 miles to the railroad at Piedra. The property embraces nine claims. On one of them is a block of chromite 12 feet deep and 6 feet wide. It contains about 60 tons of hard clean ore,[2] which gave analysis No. 1 below. In the same region another claim known as the "potato patch" contains nodules of chromite, which gave analysis No. 2 and whose relatively high content of aluminum adapts it to the manufacture of chrome brick.

Analysis of chromic iron ore from Fresno County, Cal.

	1	2
Chromic oxide	43.21	43.72
Silica	6.40	11.70
Ferric oxide	7.40	4.30
Aluminum oxide	33.80	32.40
Magnesium oxide	2.40	1.10

GLENN COUNTY.

The Black Diamond mine, in sec. 25, T. 22 N., R. 7 W., in Glenn County, about 6 miles southwest of Newville, was opened years ago, and up to 1893 more than 3,000 [3] tons of chromic iron ore had been mined and shipped by wagon 20 miles to the Southern Pacific Railroad at Fruto. The ore occurs in a belt of serpentine along the eastern slope of the Coast Range where several bodies of chromite were found during the prospecting of the original discovery by a series of open cuts, which are said to have revealed a large quantity of ore. A sample of the ore from this region furnished by W. R. Chesley was analyzed for him by the Mutual Chemical Co. of America, with the following results:

Analysis of chromic iron ore from Glenn County, Cal.

Cr_2O_3	51.61	SiO_2	1.40
FeO	18.09	MgO	13.06
Fe_2O_3	.50	CaO	.24
Al_2O_3	14.62	Loss on ignition	.40
			99.92

[1] Turner, H. W., U. S. Geol. Survey Geol. Atlas, Jackson folio (No. 11), 1894.
[2] Dolbear, S. H., Mining Press [Min. and Sci. Press], Mar. 6, 1915, p. 358.
[3] California State Min. Bur. Bull. 38, p. 268, 1906.

SAN BERNARDINO COUNTY.

According to Samuel H. Dolbear,[1] two new deposits of fairly high grade ore have been lately discovered in San Bernardino County. One of these is about 18 miles west of Hesperia, a station on the Santa Fe main line about half way between Cajon Pass and Victorville. The other is 10 miles farther on in the same direction and is not yet accessible for lack of roads. Analyses of the ore from these deposits made for Alexander Gray showed 45 to 68 per cent Cr_2O_3. An interesting feature of these ores is that they are said to contain $1.20 per ton in gold and 4 ounces silver. As one of the reasons for believing that chrome ore is a segregation from the magma is the absence of pneumatolytic minerals, the study of this deposit should be of particular geologic interest

SAN LUIS OBISPO COUNTY.

Numerous and large bodies of chromite occur in the serpentine rocks of San Luis Obispo County, and their positions are shown on the economic map of the San Luis folio. They occur along the southwestern slope of the Santa Lucia range, northwest of San Luis Obispo. Small deposits of chromite occur in the San Luis range southwest of San Luis Obispo.

Most of the deposits along the Santa Lucia Mountains occur in the vicinity of a fault zone. The following description of the deposits is given by Fairbanks: [2]

> The ore (in the Santa Lucia range) occurs in irregular and more or less disconnected veins and bunches along fissured zones in the serpentine through which mineral-bearing waters have percolated. All stages of replacement of serpentine by the chromite are exhibited, from that in which the ore appears as granules scattered through the porous serpentine to that in which it forms massive bunches many tons in weight. In the Pick and Shovel mine one mass weighing 1,000 tons is reported to have been discovered. In the vicinity of some of the mines much float ore is scattered over the surface and some attempt has been made at concentrating it. The workings have so far been superficial and the deposits are not much more than touched.

The group of mines southwest of San Luis Obispo also consists almost entirely of surface workings, which have followed irregular stringers and bunches of ore.

Fairbanks's theory that the ores were deposited by percolating waters is at variance with the ideas of other investigators of chromite deposits, who believe that these ores are largely the result of magmatic segregation.

In 1890 the California State Mining Bureau estimated that 11,000 tons of chromite had been shipped from San Luis Obispo.[3]

SHASTA COUNTY.

The chromite belt of Shasta County is in its northwest corner in a mass of serpentine and allied rocks that border Trinity County. The deposits of chromite in Shasta County have in recent years attracted more attention than any others in California. They lie near the main line of the Southern Pacific Railroad and are conveniently located for economic mining. They begin on the northern border of the county near Dunsmuir in Brown's Mine, which has been the principal producer of chromite in the State and has been in operation since 1906. This mine is within a mile of the railroad and about 700

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[1] Dolbear, S. H., Mining Press, [Min. and Sci. Press], Mar. 6, 1915, pp. 358-359.

[2] Fairbanks, H. W., U. S. Geol. Survey Geol. Atlas, San Luis folio (No. 101), p. 14, 1904; Harder, E. C., Chromic iron ore: U. S. Geol. Survey Mineral Resources, 1908, pt. 1, p. 767, 1909.

[3] California State Min. Bur. Bull. 38, p. 269, 1906.

feet above it, so that gravity plays an important part in the delivery by tramway and wagon of the ore at the railroad. The accompanying map (fig. 2) and section (fig. 3) show the locality of the mine and the position of the ore body.

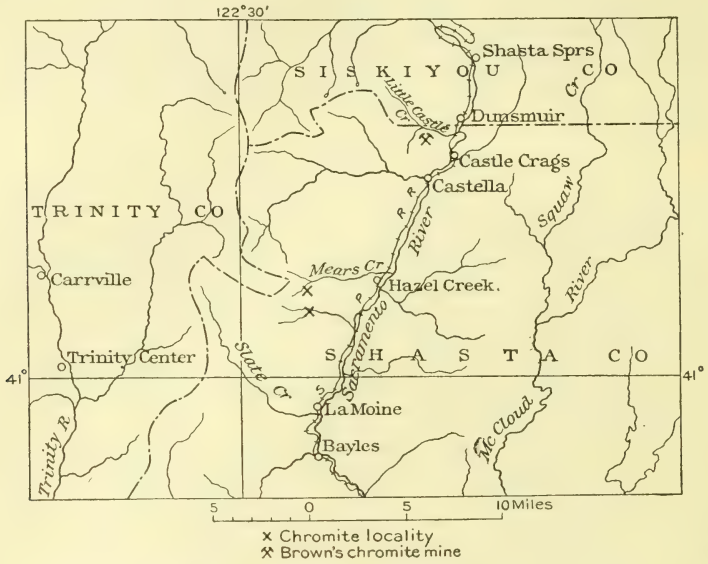

FIGURE 2.—Map showing chromic iron ore localities in Shasta County, Cal.

The ore body, about 25 feet in width, may be traced for nearly 100 feet in a direction S. 54° W. It is well exposed in an open cut that appears to promise well for future development. The country rock is chiefly pyroxenite and peridotite, more or less changed to serpentine, and both forms of rock appear to be connected with the genesis of the ore.

FIGURE 3.—Section of Brown's chromic iron ore mine, Shasta County, Cal. *a*, Pyroxenite, in some places saxonite or dunite; *b*, lean ore—granular groups of chromite in pyroxene and olivine; *c*, ore richer in chromite, pyroxene, and olivine (?) altered to chlorite and chromic chlorite.

The same body of basic rocks extends southwest for 12 miles or more across Castle Creek, Mears Creek, and Shotgun Creek, where several bodies of chromite were mined a few years ago.[1] The total output of this belt to January 1, 1915, has been approximately 3,400 long tons, but the production was larger during 1914 than ever before, amounting to 867 short tons, of which 567 were sold and 300 were stored. The average run of the ore as marketed is reported to be 45 per cent chromic oxide. A sample of the ore from Shotgun Creek as analyzed in the Survey laboratory contained 43.87 per cent Cr_2O_3.

It is of interest to note in connection with Shasta County that the Noble Electric Steel Co. has resumed operations at Heroult with a view to the manufacture of ferromanganese and ferrochrome.

[1] U. S. Geol. Survey Geol. Atlas, Redding folio (No. 138), p. 14, 1906; also California State Min. Bur. Bull. 38, p. 270, 1906.

SONOMA COUNTY.

In Sonoma County some chromic iron ore occurs at the same localities where so much magnesite has recently been found.[1] In the development of the magnesite about 100 tons of chromite is said to have been gathered from a number of small bodies near Healdsburgh in 1912 and to have remained unsold. The ore appears to be of fine quality, and being near railroad transportation and within 100 miles of San Francisco, it should be in demand.

The Mutual Chemical Co. of America has kindly furnished (Apr. 21, 1915) the following chemical analysis of the ore:

Analysis of chromic iron ore from Sonoma County, Cal.

Cr_2O_3	34.25	MgO	19.07
FeO	17.07	Ignition loss	.345
Fe_2O_3	1.77		
Al_2O_3	25.36		99.965
SiO_2	2.10		

TEHAMA COUNTY.

On the north fork of Elder Creek, west of Lowreys in sec. 16, T. 24 N., R. 7 W., in Tehama County, a body of chromic iron ore was discovered years ago and was mined in several places. The ore was hauled to Red Bluff, a distance of about 25 miles, for $5.50 a ton, and sold at $9 [2] a ton. The ore was shipped on the basis of 47 per cent Cr_2O_3 as a minimum. The last shipment was made in 1898.

CHROMIC IRON ORE IN AURIFEROUS GRAVELS.

Chromic iron ore is concentrated by the action of water with magnetite, gold, and other heavy metals in the black sand. It is common in auriferous gravels at many places, especially where the old stream beds traverse serpentine rich in particles of chromite. In the Survey folios on the Sierra Nevada such gravels have been reported on Goodyear Creek and Howland Flat [3] (Sierra County), near Meadow Valley (Plumas County), and also in the northwest corner of Bidwell Bar quadrangle [4] (Butte County). Furthermore, Mr. Samuel H. Dolbear states that 250 tons of chromite bowlders have been mined and piled on the dump at a place about 3 miles south of Magalia in Butte County. The bowlders were taken out in the course of drift mining in one of the old channels and their average content of chromic oxide is said to be 44 per cent.

ALASKA.

Brooks [5] reports chromic iron ore as occurring in a lode deposit near Port Chatham on Kenai Peninsula. Fragments of chromite ore have also been found in the gold placers of Shungnak in the upper Kobuk basin.

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[1] U. S. Geol. Survey Bull. 540, p. 490, 1914.
[2] California State Min. Bur. Bull. 38, p. 272, 1906.
[3] U. S. Geol. Survey Geol. Atlas, Downieville folio (No. 37), p. 5, 1897.
[4] U. S. Geol. Survey Geol. Atlas, Bidwell Bar folio (No. 43), p. 4, 1898.
[5] Brooks, A. H., Mineral Resources of Alaska, 1913: U. S. Geol. Survey Bull. 592, p. 36, 1914.

WYOMING.

A deposit of chromic iron ore in western Converse County, Wyo., was noted in Mineral Resources for 1908 (Pt. I, p. 766). The note referred to was based on information furnished by E. W. Merritt, president of the Chromium Mines Co., the owner of the property. Since 1908 the company has shipped about 300 tons of ore, and in March, 1915, it was endeavoring to secure capital for the installation of a mining plant and an aerial tramway 3½ miles long.

The locality is about 16 miles from Glenrock and 13 miles due south of Big Muddy, stations on the Chicago & North Western and the Burlington railroads, respectively. The mine is situated on the west side of Deer Creek, 400 or 500 feet above the bottom of the steep-walled canyon, here about 1,000 feet deep.

The following analyses of ore have been furnished by Mr. Merritt:

Analyses of chromic iron ore from Deer Creek, Wyo.

	1	2	3
SiO_2	5.72	8.64	3.70
CaO	.....	1.68	.....
MgO	12.67	13.52	.....
Al_2O_3	17.67	11.20	.....
Cr_2O_3	42.36	35.16	41.81
Iron	.....	20.29	20.87

1 and 2. Analyses of samples of crude ore reported by the Illinois Steel Co.
3. Analysis of concentrates reported by the Colorado Fuel & Iron Co.

The locality was visited in August, 1914, by A. C. Spencer, of the United States Geological Survey, who furnishes the following note:

The chromite is associated with serpentine, which occurs as a small body surrounded by hornblendic schists. The statement credited to Mr. Merritt in the 1908 report indicates that the serpentine body has a maximum width of 110 feet and that there are several separate masses of the ore. These observations were not verified by me as I visited the locality alone and, because of the steepness of the slope, was able to examine only the upper or western edge of the serpentine area. Along this edge the wall of serpentine against the schist strikes nearly north-south and dips steeply to the east. Near the wall and in a general way parallel with it is a layer of ore, which, as seen in a series of pits, has a thickness varying from 2 to 5 feet and seems to be continuous for perhaps 150 feet. There are no workings aside from the pits mentioned and it did not occur to me that there might be bodies of chromite that had not been explored. The development to date does not expose sufficient ore to place the deposit on a commercial basis.

The president of the company stated that a sample of the ore from the Deer Creek locality analyzed by the Electro Metallurgical Co., of Niagara Falls, is reported to contain 3 per cent of vanadium.

MARYLAND.[1]

The chrome industry [of the United States, both mining and manufacturing, originated in Maryland] in the discovery in 1827 of chrome ore in the serpentine of the Bare Hills in Baltimore County. Subsequently other bodies were found in the serpentines [to the northeast of Baltimore] in Harford and Cecil counties. Between 1828 and 1850 Baltimore supplied most of the chrome ore consumed by the world, the remainder coming from the serpentine and platinum washings of the Ural Mountains. After 1850 the foreign demand for Baltimore ore declined gradually until 1860, after which time almost none has been shipped abroad. The reason for this was the discovery in 1848 of great deposits of chromite in Asia Minor.

[1] Maryland Mineral Industries, 1896–1907: Maryland Geol. Survey, vol. 8, pt. 2, pp. 155–156, 1908.

Since 1866 very little has been done with the chrome deposits of Maryland, although Baltimore is still one of the most prominent manufacturing centers of chromium salts.

All the chrome ore now taken out in Maryland is in the form of sand washed from the stream deposits within the area of serpentine that contained the bodies of chromite mined out years ago by the Tyson Mining Co. Some of the sand is washed five times through a "bubble" to attain the desired degree of concentration; it is then exported and sold for the manufacture of special colors. This chromite-sand industry sprang up after the exhaustion of the ore bodies in the serpentine areas of Harford and Cecil counties of Maryland and extended up into southern Pennsylvania. Chrome sand washing continued irregularly in the Rising Sun region of Maryland up to 1900.[1] The present partial renewal of this small industry in Maryland does not appear to extend into Pennsylvania.

NORTH CAROLINA.

Numerous occurrences of chromic iron ore are known in Watauga, Yancey, Madison, Buncombe, and Jackson counties, in western North Carolina, in association with local areas of dunite. The ore occurs for the most part in small grains disseminated through the dunite, but a few deposits of commercial importance have been found. The principal deposits[2] are found 7 miles northwest of Boone, Watauga County; 4 miles north of Burnsville, Yancey County; 6 miles east of Burnsville, Yancey County; 6 miles southwest of Burnsville, Yancey County; 3 miles northeast of Stocksville, Buncombe County; 1½ miles north of Democrat, Buncombe County; half a mile west of Democrat, Buncombe County; near Webster and Balsam Gap, Jackson County.

The chromic iron ore in general occurs in two forms, as small grains disseminated through the dunite and as balls and nodules of various sizes. Only the second type is of importance as an ore. Most of the bodies are only a few inches in diameter, but a few are of larger size.

CANADA.

No production of chromic iron ore was reported in Canada during 1912 and 1913, but in 1914 a production of 136 short tons, valued at $1,210, an average of $8.90 a ton, was reported from near the asbestos district of Quebec. It is interesting to note that among the imports received at Buffalo during the fiscal year ending June 30, 1914, there were 533 tons of chromite, valued at $9,283, an average of $17.41 a ton.

In the Tulameen district of British Columbia[3] grains and masses of chromic iron ore, some of them 6 inches in diameter, have recently been found and several claims have been taken up.

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[1] Maryland Geol. Survey, Cecil County, p. 222, 1902.

[2] Pratt, J. H., and Lewis, J. V., Corundum and the peridotites: North Carolina Geol. Survey, vol. 1, pp. 381–384, 1905. Nitze, H. B. C., Iron ores: North Carolina Geol. Survey Bull. 1, pp. 212–215, 1893. Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Asheville folio (No. 116), 1904; also Mount Mitchell folio (No. 124), 1905.

[3] Camsell, Charles, Canada Geol. Survey Memoir 26, p. 56, 1913.

CUBA.

The following paragraph is quoted from a report on the mineral resources of Cuba by members of the United States Geological Survey.[1]

> Deposits of chromite were o served in the Province of Puerto Principe (now called Camaguey). Three localities were noted, the most promising of which is within 1 mile of the town of Minas on the Nuevitas & Puerto Principe Railway.
>
> A specimen picked up on the surface at this place was analyzed by Frederic P Dewey and was found to contain 56.28 per cent chromium, showing a high grade of ore. The mode of occurrence suggests the probability that there are other similar occurrences in the same general region since there are large tracts over which the same favorable geological conditions prevail.

Mr. Spencer informs the writer that since this paragraph was written he has seen other chromite deposits situated about 20 miles northwest of Minas and at an equal distance northwest of Camaguey. These localities are just north of the eastern end of the Cubitas field of surficial brown iron ores.[2]

Mining denouncements or claims known as El Cid, El Yunque, and El Teyde all show noteworthy quantities of chromite float. The ores are brilliant, rather coarsely crystalline, and evidently of high grade. Because of inadequate outcrops and the absence of development work the dimensions of the deposits can not be stated. However, study of the surface indicates the occurrence of tabular ore bodies from 1 to 5 feet wide. On El Yunque claim ore fragments measuring from 6 inches to 1 foot are distributed over an area about 250 feet long and 150 feet wide. El Cid claim shows bowlders of ore irregularly distributed over an area about 1,700 feet long. On El Teyde there are five separate deposits within an area measuring 3,000 by 1,200 feet. These ore bodies strike N. 10° E. to N. 30° E. One of them seems to be continuous for 900 feet.

Although he is aware that other engineers from the United States have reported that there are no deposits of chrome ore of workable grade in Cuba, Mr. Spencer regards the Camaguey region as one offering some possibilities. Large deposits may not exist, but so far as seen the ores are of good grade. Unfavorable features are that most of the known deposits are far from the railroad, transportation charges are excessive, and cargoes must be lightered to the vessel at Nuevitas.

FOREIGN SOURCES OF CHROMITE.

The principal foreign sources of chromite, as indicated by the tables showing the world's production, page 2, and imports, page 3, are New Caledonia, Rhodesia, Turkey in Asia, and Greece. These have been noted in previous reports and need not be referred to here. On account of the war the most important of these sources of foreign supply have been practically closed.

In this connection it is of interest to note in the report of Consul John M. Savage, Sheffield, England, that [3]—

> The most striking feature of Sheffield's trade to-day is the remarkable boom in high-speed steel. In the history of the trade nothing approaching the present demand for this article has heretofore been experienced; in fact, the present colossal requirements have never been dreamed of. Not only are orders numerous, but they are of

[1] Hayes, C. W., Vaughan, T. W., and Spencer, A. C., A geological reconnaissance of Cuba, p. 85, Havana, 1901.

[2] Spencer, A. C., Three deposits of iron ore in Cuba: U. S. Geol. Survey Bull. 340, pp. 318–329, 1908.

[3] Daily Cons. and Trade Repts., May 6, 1915.

tremendous size and value. These orders, in addition to British sources, come from Russia, France, Italy, and the United States. One order received this week from Russia amounted to 106 tons. This does not seem a large quantity when speaking of steel to those unfamiliar with the trade, but the importance of the order can be gaged by the fact that this material is quoted by the pound, and the price to-day is from 1s. 8d. (41 cents) to 4s. (97 cents), as against 1s. 4d. (32 cents) to 3s. 6d. (85 cents) in normal times.

An immense quantity of this steel is necessary in the production of armaments.

In the manufacture of high-speed steel the principal alloys used are tungsten powder or ferrotungsten, ferrochrome, and ferrovanadium, and the supply of these alloys has failed to a great extent, which has been a further handicap to manufacturers.

Ferrochrome (4 to 6 [per cent] carbon) has advanced [in price] from 30 to 35 per cent.

RECENT PUBLICATIONS CONCERNING CHROMIUM.

Cubillo, Leandro, On the manufacture of armor-piercing projectiles: Iron and Steel Inst. Jour., vol. 88, p. 248, 1913. The history and manufacture of armor plate and armor-piercing projectiles is discussed. Tensile and actual firing tests supplemented by photographs prove that of the two steels in general use the quaternary steel (Cr 0.749, Ni 2.545 per cent) is superior to the ternary steel (Cr 2.371 per cent).

Philippson, Alfred, Reisen and Forschungen im westlichen Kleinasien (III Heft): Petermanns Mitt., Erg. Heft No. 177, 1913. Describes a mass of serpentine in (eastern Mysia) western Asia Minor about Alabarda, which contains lenses of chromite, some of them being 50 to 60 meters in length and 15 meters thick.

Guillet, Leon, Compt. Rend., tome 158, pp. 412–414, Feb. 9, 1914. Discusses the transformation points and structure of nickel-chromium steel.

Walters, H. E., Metall. and Chem. Eng., vol. 12, No. 5, p. 310, May, 1914. A rapid method for the determination of chromium in pig iron, cast iron, and steel.

Senechal, A., L'Etude physico-chimique des sels chromiques, p. 29, 1913. A book review in Am. Chem. Soc. Jour., vol. 36, p. 455, 1914.

Am. Chem. Soc. Jour., Chromates: Vol. 36, p. 829, May, 1914. Colorimetric studies on the nature of chromate solutions.

Evans, Brunt, Am. Chem. Soc. Jour., vol. 36, p. 1426, July 19, 1914. Describes the volumetric determination of titanium and chromium by means of a modified radiator.

Daniels, F. C. T., The determination of chromium and manganese in iron and steel: Jour. Indust. and Eng. Chemistry, August, 1914, p. 658.

Abbott, R. R., Franklin Inst. Jour., April, 1915, p. 423. In considering modern steel and their heat treatment, Abbott remarks: "As typical examples of the two methods of increasing the strength of steel we will consider nickel and chrome steels. Nickel forms a solution or alloy with the iron which is stronger than iron alone. Chromium replaces some of the iron of cementite, forming a carbide of chromium. The pearlite thus formed from the double carbide of chromium and iron is stronger and at the same time tougher than ordinary pearlite formed without chromium. The most widely used nickel steel contains 3½ per cent nickel while the common chrome steel has about 1 per cent chrome. Such a nickel steel will be about 20,000 pounds per square inch and a chrome steel about 15,000 pounds stronger than a simple steel of the same carbon content. At the same time the toughness of the nickel steel will be about the same as that of a simple steel, while for the chrome steel it will be a little greater. It is apparent, then, that the use of an alloying element to increase the strength of steel is better than to use carbon for the same purpose, as the increased strength is not obtained at the expense of toughness."

Haynes, Elwood, A new alloy for edge tools: Iron Trade Rev., Mar. 5, 1914, p. 468. The addition of 10 per cent molybdenum to an alloy of 25 per cent chromium and 65 per cent cobalt produces a very hard composition, which makes excellent lathe tool metal. Numerous combinations have been made, some of which contain both tungsten and molybdenum as well as chromium and cobalt, and the alloys are constantly being improved from time to time.

Keeney, R. M., Electric smelting of ferrochrome: Iron Trade Rev., May 13, 1915, pp. 972–975. More ferrochrome is manufactured in the electric furnace than any other ferro-alloy except ferrosilicon. Keeney gives details of experiments in manufacturing ferrochrome directly from chromic iron ore, with analyses of typical ferrochrome and the cost of production per net ton.

RECOVERY OF SECONDARY METALS IN 1914.

By J. P. Dunlop.

INTRODUCTION.

"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, drosses, etc., and are so called to distinguish them from the metals derived from ore, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality, for metals derived both from ore and from waste material vary in purity and adaptability for use in making certain products. The reports to the United States Geological Survey do not include the large quantity of iron and steel remelted, neither do they include nickel, gold, silver, and platinum. In fact, although the data relative to lead, zinc, copper, aluminum, tin, and antimony given in this statement cover a large field and form an essential addition to the reports on primary metals, the scope of the inquiry probably reveals by less than one-half the extent of the trade in waste metals. The value of the old iron and steel reused amounts to many millions of dollars annually. The United States assay offices and private refineries recover large quantities of gold, silver, and platinum from old jewelry, sweepings, photographic waste, and dental waste. Moreover, the recovery of secondary metal is only one branch of the vast industry of utilizing waste material. There is an enormous and constantly growing trade in old rags, paper stock, old rubber tires, mats, and boots, old rope, matting, bones, and leather, and there are many industries which depend wholly or in part on old material. Only a small percentage of secondary metals is derived from old stoves, copper bottoms, and other household utensils. The manufacturing and railway centers contribute the bulk of the metal wastes, and when general trade and consequently transportation are dull the production of scrap metal and residues declines. Fewer plants are scrapped and less babbitt and bearing metals are necessary in operating.

Stocks of secondary metals were fairly large at the beginning of 1914 and metal prices were low during most of the year, so that the trade in waste metals and drosses was smaller in volume and less profitable than usual. Advancing metal prices during the latter part of 1914 and good stocks of most metals available to take advantage of higher prices made more favorable trade conditions, so that, on the whole, business for the year 1914 was not as bad as anticipated. As shown by the table at the end of this chapter, the recoveries of lead, zinc, copper, tin, antimony, and aluminum made from

scrap metal, drosses, etc., in 1914, aggregated about 287,000 short tons. As these secondary metals sell at prices only slightly lower than new metal and displace an equivalent quantity of primary metals, they must be considered in any estimate of stocks available for consumption in any year. For a few purposes requiring especial purity of material it is necessary to employ primary or virgin pig metal, but as a general rule secondary metals can be used in whole or in part. In fact most foundaries, in order to compete for business successfully, must and do use secondary material, at least in part, and hence they purchase scrap metal and remelt it with primary pig metal or with composition ingot. The secondary smelters by handling large quantities of all kinds of scrap are able so to classify their material as to produce continuously alloy metals of uniform composition suitable for use in work of different classes.

It has so far proved impossible to separate the statistics for secondary metal recovered from clean scrap made in the ordinary course of manufacture from the statistics of secondary metal recovered from drosses and ashes and from scrap or old metal that had entered the trade as manufactured articles and been used and discarded. An estimate is given of the clean copper and brass scrap on the basis of replies from the larger secondary smelters and refiners, but no classification made by many of the dealers or smelters is available.

As the figures for secondary recoveries obtained by the Survey are given as a supplement to the regular reports on primary metals in order to enable producers and consumers to form a more comprehensive idea of the quantities of metal available for consumption, no general discussion of the technology of the refining and smelting of secondary material will be made in this place. There are several publications—for example, The Waste Trade Journal, The Metal Industry, Foundry, and The Brass World—that publish many articles on the proper method of handling scrap metals and on their treatment and use. All large foundries and manufacturing plants know that a large saving is effected by the proper handling of waste material, and the use of magnetic separators to free scrap from iron and of machines to briquet small scrap is becoming more general. The following excerpt relating to the segregation of scrap is quoted from Metal Industry:[1]

> The method in most common use and the one recommended is, briefly, to segregate the scrap according to composition, to melt it in large quantities, to obtain homogeneous lots, to pig it, analyze it, and to use it, with the proper additions of virgin metals, in the manufacture of the alloy which it most nearly approximates. This method, properly applied, has no apparent ill effects upon the alloys, but, on the contrary, seems to improve their physical properties and casting qualities.
>
> The first and a most essential point is the careful segregation of the scrap according to composition. The scrap is delivered to bins built alongside the yard railroad track within a few yards of the foundry. Separate bins are provided for the stowage of scrap copper, zinc, lead, gun bronze, phosphor bronze, manganese bronze, yellow brass, and separate bins for the borings and turnings of each kind. Metallic-packing scrap is stowed in the foundry and babbitt scrap is kept in the machine shop on the babbitting floor. Nonferrous scrap coming off ships under repair is delivered in cars to the bins. Here the master molder, or a leading man, looks over the scrap and supervises its distribution into the various bins. It is a comparatively easy matter for an experienced and intelligent molder to properly separate the scrap. From the nature of the casting he can tell of what composition it was originally made and can also readily determine by the color whether it is yellow brass or "red brass." The

[1] Perkins, F. M., Lieut. U. S. N., The foundry use of nonferrous scrap metals; an interesting recital of how Uncle Sam saves money in his own shop: Metal Industry, vol. 14, No. 4, p. 140, April, 1915.

latter term applies to high copper-bearing alloys, such as gun, valve, and phosphor bronze. No trouble has been experienced in properly classifying scrap of this nature. Scrap castings containing pieces of iron or steel, such as bolts, nuts, studs, etc., are thrown to one side and the iron or steel removed before placing the scrap in the bins. Copper pipe is first taken to the blacksmith shop, placed under a hammer and flattened, and then cut in the shears into convenient lengths for charging. Heavy copper-wire condenser tubes, long pieces of sheet copper, sheet brass, etc., are also cut in the shears to convenient lengths. Light sheet copper and light copper wire are heated in an open wood fire and tamped into shape for charging. Heavy castings which are too large for charging are heated and broken up with a sledge or the drop hammer.

The proper segregation of scrap borings and turnings must commence in the machine shop where they accumulate. A removable pan for receiving borings and turnings is placed under each machine. The leading men are held responsible for seeing that the pan is changed or emptied when the kind of material to be worked on in the machine is changed. Several stations are provided for receiving the borings and turnings, each station having several labeled boxes capable of holding several days' accumulation of the various kinds of turnings. The turnings are collected about twice a week, run through a magnetic separator to rid them of what iron and steel have found their way in, and then delivered in the boxes to the foundry bins.

In handling borings and turnings special care is taken to guard against the introduction of iron or steel filings, drillings, turnings, etc. Sweepers are not allowed to use the scrap boxes for receptacles for their sweepings, as these always contain iron and steel filings and dust. Too much must not be left to the magnetic separator; it removes a large proportion of the iron and steel, but not all. The borings and turnings from babbitt and metallic packing also require care in handling; these metals are expensive and in this form are easily spoiled. Little chips of iron and brass will not melt down when these white metals are remelted, and they form hard spots which will score a rod or journal. Brass borings in particular must be kept out of white metals for, of course, they can not be removed by the magnetic separator. Metallic packing and babbitt must not be allowed to become mixed; the two metals are difficult to distinguish by sight and are usually of widely differing composition.

A little care in the machine shop will pay big dividends in the foundry in the form of increased purity and consequent increased value of the scrap. A handful of iron will ruin a hundred pounds of babbitt.

It has long been recognized that a business so large and so constantly expanding as the trade in waste metals requires more systematic business methods, a better grading and classification of metals, quicker and less expensive methods of settling trade disputes, and closer cooperation between the small collectors and dealers and the large wholesale dealers and smelters in order to obtain more favorable freight rates and the mitigation of burdensome regulations and licenses. To bring about these reforms an organization known as the Metal Section of The National Association of Waste Material Dealers was formed in 1914. A standard classification for old metals, to be effective after January 2, 1915, was adopted. As such a classification is of general interest to the owner of every foundry and manufacturing plant using nonferrous metals, it is reproduced herewith as published in the Waste Trade Journal of December 26, 1914.

Standard classification for old metals, effective January 2, 1915.

Code word.

Area 1 Delivery: (*a*) Delivery of more or less on the specified quantity up to 2½ per cent is permissible.

(*b*) If the term "about" is used, it is understood that 5 per cent more or less of the quantity may be delivered.

(*c*) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages, the arbitration committee of the National Association of Waste Material Dealers, appointed for this purpose, to determine the amount of such damages.

(*d*) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to the arbitration committee of the National Association of Waste Material Dealers, to be appointed for that purpose.

(*e*) A contract for a carload, unless otherwise agreed upon, shall mean the minimum quantity recognized by the official classification tariff of the district in which the seller is located.

(*f*) A ton shall be understood to be of 2,000 pounds, unless otherwise specified.

Base 2 Heavy copper: This shall consist of copper, not less than $\frac{1}{16}$ inch thick, and may include trolley wire, heavy field wire, heavy armature wire that is not tangled, and also new copper clippings and punchings, untinned and clean, and copper segments that are clean.

Clan 3 No. 1 copper wire: To consist of clean untinned copper wire not smaller than No. 16 B. & S. wire gage, to be free from burnt copper wire, which is brittle, and from all foreign substances.

Dale 4 No. 2 copper wire: To consist of miscellaneous clean copper wire such as of necessity would be taken out of the heavy copper and the No. 1 copper wire, but to be free of hair wire and burnt wire, which is brittle.

Edge 5 Light copper: Shall consist of the bottoms of kettles and boilers, bathtub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free of visible iron, brass, lead, and solder connections, old electrotype shells, and free of excessive paint, tar, and scale.

Face 6 Composition or red brass: Shall consist of red scrap brass, valves, machinery bearings, and other parts of machinery, including miscellaneous castings made of copper, tin, zinc, and ore lead, no piece to measure more than 12 inches over any one part, to be free of aluminum and manganese, also free of railroad boxes, cocks, and faucets, gates, pot pieces, ingots, and burned brass.

Gage 7 Railroad bearings: Shall consist of railroad boxes or car journal bearings, must be old standard used scrap, free of yellow boxes, plastic and similar bearings, also iron-backed boxes, and must be free of babbitt; also free of excessive grease and dirt.

Hive 8 Cocks and faucets: To be mixed red and yellow, free of gas cocks and beer faucets; shall be at least half red.

Iris 9 Heavy yellow brass: Shall consist of heavy brass castings, rolled brass, rod brass ends, brass screws, and tinned or nickel plated brass tubing; to be free of iron and dirt, and must be in pieces not too large for crucibles; no piece to measure more than 12 inches over any one part. Must also be free of aluminum manganese mixtures. Condenser tubes shall not be considered as heavy brass.

Jolt 10 Light brass: Shall consist of light sheet brass, forks and spoons, miscellaneous brass that is too light for heavy, but to be free of any visible iron, gun shells containing paper or iron, loaded lamp bases, and of clockworks.

Lark 11 New brass clippings: Shall consist of the cuttings of new sheet brass to be absolutely clean and free from any foreign substances.

Mint 12 Brass tubing: Shall consist of brass tubing, free of nickel plating, tinned, soldered, or tubes with cast brass connections. To be sound, clean tubes, free of sediment and condenser tubes.

Code word.	
Nook 13	No. 1 composition turnings: To be free of aluminum, manganese, plastic and yellow brass turnings, not to contain over 2 per cent iron, to be free of grindings or foreign material, especially babbitt, and free from adulterations made to resemble metal. Turnings not according to this specification subject to sample.
Oral 14	No. 1 yellow brass turnings: Shall consist of strictly rod turnings, free of aluminum, manganese, composition, and tobin turnings. Not to contain over 3 per cent of iron, oil, or other moisture, to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.
Pike 15	No. 1 pewter: Shall consist of tableware and soda fountain boxes, but in any case must test 84 per cent tin. Siphon tops to be treated for separately.
Quip 16	Autoradiators: To be classed separately, must be free of iron.
Reef 17	Zinc: Must consist of clean sheet and cast zinc, also cast batteries to be free of loose oxide and dross, salammoniac cans, and other foreign materials.
Skim 18	Tin foil: Shall consist of pure foil free of lead compositions and other foreign ingredients and matters.
Tack 19	Electrotype shells: Must be hand picked and free of dross.
Upas 20	Packages: Shall be good strong packages, suitable for shipment, and each package to be plainly marked with the gross and tare weights, so that when packages reach their destination their weights can be easily checked. When goods are not packed according to the above specifications and shipper wants his rejections returned, the cost of labor shall be charged to the shipper.

It is impracticable to segregate the statistics relating to the refining, remelting, and reusing of secondary metals according to States, but more than 90 per cent of the refining and smelting of drosses and scrap metals in the United States is confined to the territory east of St. Louis and north of Ohio River. Reports were made by approximately 550 users of secondary material, of which about 140 were in Pennsylvania and West Virginia, 160 in New York, New Jersey, Connecticut, Massachusetts, and Maryland, 90 in Ohio and Michigan, and 80 in Illinois, Indiana, and Wisconsin.

About 44 per cent of the secondary aluminum was reported from the States of Ohio and Michigan, 44 per cent from Illinois and Wisconsin, and 8 per cent from New York, New Jersey, and Massachusetts.

Smelters and refineries in St. Louis and Chicago recovered about 45 per cent of the antimony in alloys and those in New York and Philadelphia about 30 per cent. The largest recoveries from tin dross, tin scruff, and clean tin scrap were made in Pennsylvania, New York, and New Jersey. The recoveries of lead, zinc, brass, and copper, and of such alloys as babbitt, bronze, and pewter, were more generally distributed. The greatest number of the larger smelters or refiners of secondary metals are located at or near New York, Philadelphia, Chicago, Pittsburgh, St. Louis, Detroit, Cincinnati, Cleveland, and Tottenville (N. Y.), though there are many large and small plants at other places.

The value of the secondary metals exclusive of gold, silver, platinum, iron, steel, and ferro-alloys, recovered in the United States in 1914 was $57,039,706, compared with $72,786,027 in 1913. The decrease was partly due to smaller output and partly to lower average prices for copper, zinc, lead, tin, and aluminum.

SECONDARY COPPER.

The total quantity of secondary copper recovered in 1914, on the assumption that the brass remelted had an average copper content of 70 per cent, was 127,882 tons, of which 15,964 tons (about 2,700 tons

less than in 1913) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 36,658 tons of pig copper, 5,934 tons of copper in alloys other than brass, and 69,326 tons of copper in remelted brass. These figures indicate a decrease for 1914 of about 2,700 tons of pig copper and 50 tons of copper in brass and a decrease of about 5,600 tons in alloys other than brass. At least 40,000 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only about 77,800 tons was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. The value of the copper, both as metal and in alloys, is computed at the average yearly price quoted for casting copper by the American Metal Market. According to the Bureau of Foreign and Domestic Commerce, the exports of scrap brass, fit only for remanufacture, for the calendar year 1914 were 10,420 tons, and the imports were 2,565 tons. Many railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports received show that the railways utilized in their own shops and foundries over 12,069 tons of brass, in addition to 700 tons of copper and 1,362 tons of copper in alloys other than brass.

The production of copper from secondary sources in 1914 was equal to about 16.7 per cent of the refinery output of primary copper in the United States from all sources, or about 22.2 per cent of the primary copper smelted from domestic ore.

SECONDARY LEAD.

The secondary lead recovered in 1914 amounted to 61,062 tons, or about 11,800 tons less than in 1913. The secondary lead recovered as pig lead decreased about 3,700 tons, although the recovery of secondary lead made by those smelters whose product is mainly primary metals was slightly more in 1914 than it was in 1913. The recovery of lead in alloys decreased more than 8,000 tons, compared with 1913. This decrease in both pig lead and lead in alloys was undoubtedly due to slackened building operations, railroad traffic, and manufacturing. A large portion of the recovered lead in alloys was derived from old babbitt, solder, type metals, and white metal drosses. The main sources of secondary pig lead are old pipe, lead cable, battery lead, and lead lining of acid tanks. Regular smelters reported the recovery of 11,108 tons of lead from scrap lead and scrap antimonial lead.

The total output of secondary lead was equal to 11.3 per cent of the primary refined lead produced in the United States in 1914, compared with 15.2 per cent in 1913. It was exceeded by the primary domestic lead output of only three States—Missouri, Idaho, and Utah.

SECONDARY ZINC.

The output of secondary zinc (including that in brass) amounted to 71,642 tons and equaled 20.3 per cent of the production of primary spelter in the United States in 1914, compared with 23 per cent in 1913. The recovery was about 8,000 tons less than in 1913, of which decrease more than 5,000 tons was the loss in redistilled spelter from drosses and skimmings. The zinc recovered in alloys other than brass

amounted to 3,914 tons, compared with 3,743 tons in 1913. Of the 42,969 tons of secondary zinc recovered as spelter, 20,545 tons were obtained by redistillation from drosses and skimmings. Of this quantity 6,580 tons were obtained by smelters whose principal source of zinc is from ore. This was about 1,800 tons less than the recovery from drosses and skimmings in 1913. In addition to the 31,723 tons of remelted and redistilled spelter it is estimated that at least 8,000 tons of zinc chloride was made and likewise about 32,800 tons of the zinc pigment lithopone (containing approximately 32 per cent zinc sulphide and oxide). The zinc used in both of the last-named products is derived almost altogether from zinc drosses and skimmings. The exports of zinc drosses, which only amounted to 28 tons in 1913, increased to 2,526 tons in 1914.

Three smelters in New Jersey, New York, and Pennsylvania, which treat only drosses and skimmings, used large graphite retorts of 600 to 800 pounds capacity instead of the small clay retorts used by smelters treating ore or mixed ore and drosses. The many uses of zinc drosses and skimmings create active competition for their purchase. Considerable zinc is recovered by sweating, and the residues are then sold for redistillation. The secondary spelter varies in quality just as the spelter derived from ore does, but a large portion of the secondary spelter is reported to be of excellent quality.

SECONDARY ANTIMONY.

The production of secondary antimony, of which all but 1 ton was recovered in alloys, decreased from 2,705 short tons in 1913 to 2,646 tons in 1914. The value given is arbitrary and is based on the average yearly price for ordinary brands of antimony published by the American Metal Market. The only antimony ore of domestic origin smelted in the United States in 1914 was about 60 tons from Mill City, Nev., which was mined in 1907. The regular smelters reported the recovery of 140 tons of antimony contained in antimonial lead scrap. The principal materials refined or remelted which contained antimony as an alloy were hard lead drosses, babbitt, solder, pewter, and type metal. The 1914 imports of antimony as metal in ore or as oxide amounted to 7,528 tons, and the recovery from secondary sources was equal to 35.2 per cent of the imports. The secondary recoveries of antimony were 117 tons more than the antimony content of lead ores of domestic origin smelted in 1914.

SECONDARY TIN.

Apparently there were no domestic tin ores smelted in the United States in 1914, though some tin concentrates were shipped from Nome, Alaska, to Singapore, Federated Malay States, for treatment, and there was considerable agitation for the domestic smelting of both Alaskan and Bolivian tin ores. An increased output from Alaska may result in establishing a tin smelter on the Pacific coast. This condition makes secondary tin an important factor in supplying domestic consumption. The secondary tin recovered in 1914 was equal to 26.2 per cent of the tin imported, as metal or as oxide, into the United States during the year (47,525 short tons). Secondary-tin recoveries decreased from 14,178 tons, valued at $12,567,379, in 1913 to 12,447 tons, valued at $8,887,158, in 1914. The quantity

recovered as tin was 4,535 tons and that in alloys and chemical compounds 7,912 tons. The value of the recovered tin here given is arbitrary and is based on the yearly average price given by the American Metal Market. It will be noted that the secondary tin in alloys increased about 150 tons, and that the secondary pig tin decreased about 1,900 tons, a condition partly attributable to the large quantity of tin chloride made from clean tin scrap.

The recovered tin in alloys includes the tin content of products of several plants made from clean tin scrap. This included some tin oxide, putty powder, etc., but consisted mainly of tin chloride. The production of these compounds is calculated as metal and not separately stated, in order to avoid disclosing confidential information. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin. Two forms of tin chloride are handled commercially—stannic and stannous salts. Stannic chloride is usually sold either as a water solution, called bichloride of tin, or as an anhydrous sirupy liquid, termed tetrachloride of tin, and is used principallly in the silk industry. Stannous chloride is sold in the form of crystals and is used in dyeing and calico printing. The dry chlorine process was used to recover the tin from the clippings in some places. In others reverberatory furnaces were used to remove the tin coating, and a large quantity of tin was recovered in the form of a tin powder by the electrolytic treatment of clean scrap, the powder being sent to secondary smelters. The largest recoveries of tin were made from the scruff and drosses that occur in making tin and terneplate and amounted to over 4,000 tons.

In 1914 and in 1913 only one firm reported using old tin containers, from which the tin and solder were first sweated and the black plate was then remelted to make sash weights. Comparatively large quantities of tin scrap and old tin cans are used in the western mining regions for the precipitation of copper from mine waters. However, the tin coating of the scrap does not enter into the reaction and is lost entirely. It was not possible under prevailing conditions of lower tin prices and a stagnant market for the scrap black plate to utilize used old tin-coated containers for the recovery of the tin. The ordinary can used for food seldom carries more than 2 to 2.5 per cent of tin coating, and gasoline cans and tin buckets have a much lighter coating. It was stated by operators of detinning plants that there had been a decline in the thickness of the tin coating on much of the tin plate marketed in 1914. The principal alloys in which secondary tin was recovered were solder, bearing metals, bronze, pewter, and electrotype metal.

SECONDARY ALUMINUM.

The recovery of secondary aluminum as pig aluminum or in alloys in 1914 amounted to 4,522 tons, valued at $1,673,140, as compared with 4,654 tons, valued at $2,199,480, in 1913. The quantity recovered in alloys amounted to 1,731 tons, nearly all of which was an alloy of 92 per cent aluminum and 8 per cent copper. Most of the secondary aluminum was recovered from clean clippings and borings and was probably all used in making castings. It is stated on good authority that aluminum remelted from clippings can not be utilized

for sheet aluminum. The reason is believed to be that a layer of superficial oxide is formed on the sheet that causes planes of separation in an ingot made from clippings. Such ingots when rolled will crack.

RECOVERY.

The following table shows the recovery of secondary metals in the United States in 1914:

Recovery of secondary metals in the United States in 1913 and 1914, in short tons.

Metal.	1913		1914	
	Quantity.	Value.	Quantity.	Value.
Secondary copper, including that in alloys other than brass	66,980	$20,536,068	58,556	$15,435,362
Remelted brass	99,315	24,651,969	99,038	21,054,300
Secondary lead	33,104	6,409,392	29,337	4,762,836
Recovered lead in alloys	39,730		31,725	
Secondary spelter	50,005	6,019,776	42,969	4,782,066
Recovered zinc in alloys other than brass	3,743		3,914	
Secondary tin	6,415	12,567,379	4,535	8,887,158
Recovered tin in alloys	7,763		7,912	
Secondary antimony	45	401,963	1	444,844
Recovered antimony in alloys	2,660		2,645	
Secondary aluminum	2,198	2,199,480	2,791	1,673,140
Recovered aluminum in alloys	2,456		1,731	
Total		72,786,027		57,039,706

SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES IN 1914.

(MINES REPORT.)

By B. S. Butler and J. P. Dunlop.

INTRODUCTION.

By J. P. Dunlop.

The following is an account of the production of silver, copper, lead, and zinc in 1914 by the mines of the Central States, including Arkansas, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States which extends from the Appalachian system to the Rocky Mountain front, excluding the Black Hills. Most of the mines are developed in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each mine in operation and represent the quantity of metals recovered or paid for in the ore that was treated or sold during the year.

The method of marketing and recording the mine output in the lead and zinc regions of the United States differs from that employed in the Western States. In the Western States the miner usually sells his ore according to the assay content of metal at a certain price per unit. In the lead and zinc regions of the Central States, however, where the material sold is principally concentrates,[1] payment is made according to a basis price for a certain quality of concentrates. The details of this method are given in the pages devoted to Missouri. The figures reported to the Survey by producers represent the quantity and assay content of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted.

In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced during the year but not smelted has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

[1] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES.

Much of the ore mined in the Western States is crude smelting ore; that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of tonnage of crude ore, or "dirt," as it is usually called in the lead and zinc regions of the Central States. However, in those States it is only the larger companies which make any record of the crude ore raised. In the Joplin and upper Mississippi Valley regions the number of cans of ore hoisted is usually recorded and the approximate weight of the cans is generally known. Thus each company knows, in a general way, about what percentage of concentrates the mine run is yielding. Knowing the total production of concentrates and the average yield of concentrates from crude ores, one can arrive at a close estimate of the crude ore raised. Only the actual operating companies have the data, however, and it was the practice of the Survey, in order to shorten the list of producers as much as possible, to send requests only to the owners of the mining land or the companies holding first leases and to depend upon them to report the whole production of the tract. In 1911, 1912, 1913, and 1914 not only the first lessees of the land reported to the Survey, but also most of the sublessees gave data regarding both concentrates produced and "dirt" or ore milled. The tables of ore tenor which follow in the sections devoted to the respective States show the comparative percentages for the last three years. In certain States, notably Iowa, Kentucky, and the southern part of Illinois, it was not possible or advisable to make such calculations.

In Kentucky and southern Illinois the lead and zinc ores are recovered as by-products in the concentration of the fluorspar which they accompany. In Iowa since 1909, inclusive, the quantity of ore raised has been so small and the number of producers so limited that the calculation of averages and of the production of crude ore would be misleading.

Tenor of copper, lead, and zinc ores of Central States, 1912–1914.

State.	1912		1913		1914	
	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*	*Short tons.*	*Per cent.*
Arkansas	32,755	2.8	13,000	4.44	20,000	4.10
Illinois (northern)	147,859	3.6	119,200	2.9	261,300	2.49
Kansas	744,254	1.9	590,300	2.3	540,500	2.58
Michigan	11,411,941	.96	7,016,370	.968	9,269,413	.89
Missouri	13,385,511	2.4	[b] 12,309,000	2.45	11,492,300	2.70
Oklahoma	293,500	3.1	581,100	3.57	763,920	3.02
Wisconsin	1,363,636	3.1	1,406,000	2.73	1,387,490	2.91
Total	27,379,456	.....	22,034,970	.....	23,734,923	.....

[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper; in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of ore tenor given in the sections devoted to the respective States.

[b] A small quantity of copper ore included.

This table shows that from silver, copper, lead, and zinc mines of the Central States 23,734,923 short tons of ore were treated in 1914, as against 22,034,970 short tons in 1913, an increase of about 1,700,000 tons. The ore production of the copper mines of Michigan increased more than 2,250,000 tons. The ore production of Missouri declined more than 800,000 tons. This decrease was entirely due to the smaller output of zinc ores in the Joplin region, especially from the "sheet ground" mines. There were no radical changes in the quantity of ore mined and treated in Wisconsin, Kansas, or Arkansas, but the output from Illinois doubled and that of Oklahoma increased about 180,000 tons.

The quantity of ore mined and treated from copper, lead, zinc, and lead-zinc mines in the Central States in 1914 was approximately two-thirds as much as the total ore of that description sold or treated by mines in both the Eastern and the Western States in 1913, and was 18 per cent of all the metallic ores from domestic mines sold or treated in 1913.

The low average tenor of the metal content of crude ore mined in the Central States in 1914 is best shown by the fact that the average value of the recoverable metal content was only $2.33 per ton of crude ore treated, or 30 cents less per ton than in 1913.

PRODUCTION.

The total value of the mine production of silver, copper, lead, and zinc in the Central States in 1914 was $55,171,306, a decrease of $2,840,686 from the value for 1913. The total value of the production of these metals for the years 1907 to 1914, inclusive, was $518,267,549, of which $238,395,086 was for copper, $153,883,998 for zinc, $124,151,390 for lead, and $1,837,075 for silver.

SILVER.

The production of silver in the Central States in 1914 was 482,983 fine ounces, which, at the average price of 55.3 cents per fine ounce (5.1 cents lower than in 1913), was valued at $267,089, as compared with 335,634 fine ounces, valued at $202,723, in 1913. Nearly all the silver that is produced in the Central States is recovered incidentally to the production of other metals. Of the 1914 production 413,500 ounces came from the copper lodes of Michigan, an increase of 118,327 ounces resulting from a much larger copper output. About 25 per cent of the concentrates from lead ores mined in southeastern Missouri were desilverized and yielded nearly all the production of silver from that State recovered in 1914; a small output of silver was also derived from copper ore, and the total recovery from Missouri amounted to 61,168 ounces. A few ounces of silver were also obtained in 1914 from copper ore shipped from Lafayette County in Wisconsin.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, and from the lead concentrates derived from Illinois 2,112 ounces of silver were recovered, a decrease of 1,429 ounces. The only productive silver mine in the Central States in 1914 was one near Byars, in McClain County, Okla., which produced ore that yielded 6,187 ounces of silver, valued at $3,421.

COPPER.

The mine production of copper from the Central States in 1914 was from the States of Michigan, Missouri, and Wisconsin, the first-named State, as in other years, contributing nearly the entire output, which amounted to 164,398,821 pounds. The copper production of Michigan in 1914 was 164,344,058 pounds, which, at the average New York price of 13.3 cents a pound, was valued at $21,857,759, as against a yield of 135,853,409 pounds, valued at $21,057,278 in 1913. The copper produced in Missouri in 1914, amounting to 44,463 pounds, valued at $5,914, was derived mainly from concentrates recovered in dressing the lead ores of southeastern Missouri, but part came from oxidized ore carrying copper and silver, which was shipped from the Swansea mine in Ste. Genevieve County, Mo.

The small production of copper in Wisconsin is notable in that it was the first recorded shipment of ore for many years from the old prospects near Dunbarton, Lafayette County, in southwestern Wisconsin.

The total production of copper from Michigan and Missouri in 1914 was 27,969,208 pounds more than in 1913, when the yield was less than in any year since 1907.

LEAD.

The mine production of lead in the Central States in 1914 was 203,845 short tons, which, rated at the average New York price for the metal for the year of 3.9 cents a pound ($78 a ton), was valued at $15,899,910, as compared with 187,701 short tons, valued at $16,517,688, in 1913. Although the output of lead increased 16,144 tons in 1914, the value decreased $617,778. In 1914 Missouri produced 94.5 per cent of the lead yield of the Central States, and the recoverable lead content of galena and lead carbonate concentrates mined in Missouri in 1914 equaled 37.6 per cent of the refined primary lead recovered in the United States from domestic ore. Of the total lead output of Missouri the "disseminated lead" district of southeastern Missouri produced 168,014 tons, again exceeding the yield from the Cœur d'Alene district of Idaho and retaining first place in lead production in the United States. Southwestern Missouri was the next largest producing district in the Central States, with an output of 24,598 tons, or 3,960 tons less than in 1913. Oklahoma increased its lead production from 6,228 tons in 1913 to 7,556 tons in 1914, and its output was nearly three times as great as that of Wisconsin and Kansas, though in 1912 both Kansas and Wisconsin were larger producers of lead than Oklahoma. The lead output in 1914 from mines in Illinois, Wisconsin, Kansas, and Kentucky was considerably less than it was in 1913.

ZINC.

The mine production of zinc in the Central States in 1914, based on mine returns with a deduction for separating and smelting losses, was 168,032 short tons, valued at $17,139,264. The value is computed at 5.1 cents per pound of spelter ($102 per ton), the average St. Louis price for the metal. The production in 1913 was 179,866

short tons, valued (at $112 per ton) at $20,144,992. The decrease in 1914 was 11,834 tons in quantity and $3,005,728 in value. The spelter production of the Central States was about 49 per cent of the total production of primary spelter from domestic ores in the United States in 1914, as compared with 56.3 per cent in 1913.

The State of Missouri, although the production declined about 19,000 tons, was again in 1914 much the largest producer of zinc in the United States. Its production was 105,994 tons, against 124,963 tons in 1913. Wisconsin produced 31,113 tons in 1914, against 30,110 in 1913. The output from Arkansas increased 130 tons, that of Illinois 2,575 tons, that of Kansas 1,196 tons. The production from Kentucky decreased from 327 tons in 1913 to 230 tons in 1914. The output of Oklahoma, which had increased from 5,769 tons in 1912 to 11,664 tons in 1913, again increased to 13,992 tons in 1914.

SUMMARY OF PRODUCTION BY STATES.

The total value of the mine production of silver, copper, lead, and zinc in the Central States in 1914 was $55,171,306, as appears from the following table:

Mine production of silver, copper, lead, and zinc in the Central States in 1914, by States.

State.	Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Pounds.*		*Short tons.*		*Short tons.*		
Arkansas					41	$3,198	608	$62,016	$65,214
Illinois	2,112	$1,168			717	55,926	4,811	490,722	547,816
Iowa									
Kansas					1,409	109,902	11,284	1,150,968	1,260,870
Kentucky					16	1,248	230	23,460	24,708
Michigan	413,500	228,665	164,344,058	$21,857,759					22,086,424
Missouri	61,168	33,826	44,463	5,914	192,612	15,023,736	105,994	10,811,388	25,874,864
Oklahoma	6,187	3,421			7,556	589,368	13,992	1,427,184	2,019,973
Wisconsin	16	9	10,300	1,370	1,494	116,532	31,113	3,173,526	3,291,437
Total	482,983	267,089	164,398,821	21,865,043	203,845	15,899,910	168,032	17,139,264	55,171,306
Total, 1913	335,634	202,723	136,429,613	21,146,589	187,701	16,517,688	179,866	20,144,992	58,011,992
Total, 1912	568,622	349,702	218,579,133	36,065,556	186,891	16,820,190	191,307	26,440,366	79,675,814
Total, 1911	550,184	291,598	220,480,513	27,560,064	188,669	16,980,210	172,698	19,687,572	64,519,444
Total, 1910	365,702	197,479	222,777,913	28,292,795	171,226	15,067,888	178,784	19,308,672	62,866,834
Total, 1909	301,629	156,848	234,136,529	30,437,749	168,221	14,467,006	175,337	18,936,396	63,997,999
Total, 1908	292,237	154,885	223,286,700	29,473,844	153,361	12,882,324	146,975	13,815,650	56,326,703
Total, 1907	328,411	216,751	217,767,232	43,553,446	146,379	15,516,174	156,027	18,411,086	77,697,457

LEAD AND ZINC PRODUCTION, BY REGIONS.

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to any single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary and are so given. For practical purposes, however, it seems desirable to compile the production by the natural regions irrespective of State lines.

The seven regions are as follows, in order of importance of output: (1) The Joplin region, comprising the district in southwestern Missouri, southeastern Kansas, and northeastern Oklahoma; (2)

southeastern Missouri, containing the great disseminated lead deposits; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwestern Wisconsin, Iowa, and northwestern Illinois; (4) northern Arkansas; (5) the Kentucky-Illinois fluorspar region in southern Illinois and northern Kentucky; (6) central Missouri;[1] (7) the Arbuckle Mountain region in southern Oklahoma.[2]

The southeastern Missouri region produced about 82.6 per cent of the lead output of the Central States and about 32.8 per cent of the production of lead recovered from domestic ore in the United States in 1914. The Joplin region produced 16.2 per cent of the lead and 78 per cent of the zinc of the Central States in 1914, and was much the largest producer of zinc in the United States, yielding about 38.2 per cent of the total spelter production from domestic ores. The upper Mississippi Valley region produced a little less than 1 per cent of the lead and 21.4 per cent of the zinc produced in the Central States in 1914.

Mine production of lead and zinc in the Central States in 1914, by regions, in short tons.

Region.	Concentrates.				Total value of concentrates.
	Lead.[a]		Zinc.[b]		
	Quantity.	Value.	Quantity.	Value.	
Joplin	41,899	$1,956,498	259,099	$9,512,606	$11,469,104
Southeastern Missouri[c]	249,165	9,710,125	537	11,982	9,722,107
Upper Mississippi Valley	2,674	113,974	128,047	2,282,171	2,396,145
Northern Arkansas	52	2,408	1,886	44,493	46,901
Kentucky-southern Illinois	334	13,116	644	12,168	25,284
Total	294,124	11,796,121	390,213	11,863,420	23,659,541
Total, 1913	270,664	12,201,913	400,881	13,521,743	25,723,656

Region.	Metal.				Total value of metal.
	Lead.		Zinc.		
	Quantity.	Value.	Quantity.	Value.	
Joplin	33,138	$2,584,764	131,085	$13,370,670	$15,955,434
Southeastern Missouri[c]	168,439	13,138,242	185	18,870	13,157,112
Upper Mississippi Valley	1,986	154,908	35,924	3,664,248	3,819,156
Northern Arkansas	41	3,198	608	62,016	65,214
Kentucky-southern Illinois	241	18,798	230	23,460	42,258
Total	203,845	15,899,910	168,032	17,139,264	33,039,174
Total, 1913	187,701	16,517,688	179,866	20,144,992	36,662,680

[a] Includes both galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.
[c] Includes a small production from the central Missouri region.

[1] Owing to the small output from the central Missouri region it has in this report, for convenience, been included in the southeastern Missouri region.
[2] No production reported in 1913 or 1914.

ARKANSAS.[1]

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Arkansas in 1907 to 1914 is shown in the following table:

Mine production of lead and zinc in Arkansas, 1907–1914, in short tons.[a]

Year.	Ore.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Silicate and carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1914	52	$2,408	743	$19,406	1,143	$25,187	41	$3,198	608	$62,016
1913	23	1,179	594	16,916	680	15,050	18	1,584	478	53,536
1912	39	2,180	1,419	56,235	462	11,231	31	2,790	748	103,224
1911	80	4,321	1,407	40,425	183	4,239	64	5,760	664	75,696
1910	80	3,714	1,857	74,136	128	2,641	63	5,544	994	107,352
1909	30	1,800	896	33,948	98	2,736	24	2,064	510	55,080
1908	18	985	516	18,270	939	21,469	15	1,260	605	56,870
1907	15	800	538	15,233	663	16,210	12	1,272	474	55,932

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in the case of zinc but not in case of lead. In comparing the values of ore and of metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Tenor of lead and zinc ore and concentrates produced in Arkansas in 1913 and 1914.

	1913	1914
Total crude ore.....short tons..	13,000	20,000
Total concentrates in crude ore:		
Lead.....per cent..	.17	.26
Zinc.....do....	9.8	9.4
Metal content of crude ore:		
Lead.....do....	.14	.2
Zinc.....do....	4.3	3.9
Average lead content of galena concentrates.....do....	78.3	78.9
Average zinc content of sphalerite concentrates.....do....	48.0	44.7
Average zinc content of zinc silicate and carbonate.....do....	40.6	40.0
Average value per ton:		
Galena concentrates	$51.24	$46.31
Sphalerite concentrates	$28.48	$26.12
Zinc silicate and carbonate	$22.13	$22.04

NORTHERN ARKANSAS.

Lead and zinc deposits have been known in Arkansas for many years. Lead was noted by Schoolcraft in his travels in 1819, and, owing to the demand of the pioneers for lead and the comparative ease with which it could be smelted, lead ore was mined and smelted many years before the deposits of zinc ore were known or utilized. In 1851 or 1852 a small quantity of pig lead was reported to have been shipped to Springfield, Mo., from a smelter operated by one

[1] The assistance rendered by Prof. R. W. Willett, of Yellville, Ark., in the preparation of this report is very gratefully acknowledged.

William Bennett, on West Sugar Loaf Creek.[1] Subsequently to 1852 and prior to 1864 there were two small lead smelters in operation near the town of Lead Hill, in Boone County. Two smelters were again operated in 1873 and 1874, near Lead Hill, the galena being obtained from shallow workings in the vicinity of the smelters. The production was only about 50 tons.

The Boston Mountain & Mining Co. smelter at Cave Creek, in Newton County, shipped several carloads of pig lead from Russellville in 1876 and 1877. Other smelters were operated in 1878 and in 1882 and 1883, but the total output was small.

The earliest zinc mining recorded in Arkansas was at Calamine, in Sharp County, when a smelter which treated only zinc carbonate ore was erected in 1857. Operations at this plant ceased at the outbreak of the Civil War. In 1871–72 a smelter was again built and operated at Calamine, but no statistics are available as to the production. Considerable prospecting and some mining was carried on for many years, but the present development has mainly been accomplished since 1899, when there was a great rush to the northern Arkansas field. The mines are principally in Boone and Marion counties and in the adjoining portions of Searcy and Newton counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and deposits have been worked in Washington and Sevier counties, on the extreme western border of the State.

The ores are galena, sphalerite, and smithsonite, and the concentrates produced are generally high grade and free from, or very low in, iron or lime. The sphalerite has frequently assayed 2 or 3 per cent above the price basis of 60 per cent metallic zinc content. In 1914, as in 1913, nearly all the concentrate classed as sphalerite was mixed sphalerite and zinc carbonate mined from shallow workings. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, especially in a yellow variety of smithsonite, known locally as "turkey fat," which shows as high as eight-tenths of 1 per cent of cadmium. The ore bodies occur in fissures or crevices, in fault breccias, and in solution breccias. The ore deposits are for the most part found in limestone of early Ordovician age, but some also are found in the Boone limestone of Mississippian (lower Carboniferous) age.

Although not so advantageously situated as the mines in the Joplin region, most of the productive properties in northern Arkansas since the completion of the White River branch of the St. Louis, Iron Mountain & Southern Railway and of the St. Louis & North Arkansas Railroad, are within 12 miles of railway transportation. The longer railway haul being taken into consideration, ore prices compare favorably with those of other regions. There have been complaints that owners of Arkansas mining lands have an inflated idea as to their value both for purchase and leasing. It would possibly be a good policy to sell small tracts for moderate prices or to lease on a royalty based on the selling price of zinc concentrates. There are in Arkansas about 20 concentrating plants of the Joplin type, averaging about 100 tons in daily capacity; but few of them have been operated in recent years. In 1913 not a single concentrating plant was operated,

[1] Branner, J. C., Arkansas Geol. Survey Ann. Rept., vol. 5, pp. 64–67, 1892.

though at two mines steam crushers were used in conjunction with hand jigs, and in 1914 only four plants were operated during a part of the year. Wood is universally used for fuel and costs about $2.50 a cord, delivered at the mine. Mining methods are similar to those in vogue in the Joplin region except that, owing to the rugged character of the country, many deposits of ore outcrop on the hillsides and have been followed in by tunnels.

The unfortunate experience of early investors in stocks of mining companies operating in the Arkansas field restricted development and has made it extremely difficult to interest outside capital. Litigation and also the inflated ideas of owners as to the value of lead and zinc mining lands have prevented the mining of known ore deposits. Many of these deposits can be and are now operated profitably in a small and inexpensive manner. Occasionally prospects will develop into mines which need a milling plant, but development work assuring sufficient ore to pay for such a plant should be blocked out before building a mill. The ores are usually rich, and a small plant of 40 to 50 tons capacity similar to those first constructed in the Wisconsin field is usually large enough for the Arkansas field.

The construction of good roads to reduce the expense in the transportation of supplies and in marketing concentrates and a low royalty on mining lands would tend to induce many small operators to develop the field. There are numerous ore deposits which can be cheaply mined by means of short tunnels. An increased number of small operators who will open such deposits probably would lead to the location of extensive ore bodies requiring concentration plants. There was a considerable increase in the number of operators and in the quantity of zinc concentrates sold in 1914. Part of this increase was due to the operation of several of the larger concentrating plants. It is doubtful, however, if their operation was profitable under the prevailing low prices for ore and the large investment in plants, for unless such plants can be run steadily on a good supply of ore the operating expenses are too great to permit of any profit. It is to be hoped that the shafts being sunk at several of the larger mining properties will result in obtaining sufficient ore to supply the mills steadily.

It has been shown that the mining of zinc carbonate ores is profitable under local conditions in Arkansas, and there is no adequate reason why the production of hand-cobbed and hand-jigged concentrates should not be many times as large as it was in 1914. The development work being done and the early shipments of 1915 indicate a largely increased output.

The total value of the lead and zinc produced in Arkansas in 1914 was $65,214, as against $55,120 in 1913. The shipments of lead concentrates from three mines increased from 23 tons in 1913 to 52 tons in 1914. The production of sphalerite and of mixed sphalerite and zinc carbonate concentrates was 743 tons, or 149 tons more than in 1913. The mixed concentrates sold in 1914 amounted to about 75 per cent of the production from milling plants. The sales of zinc carbonate concentrates increased from 680 tons, valued at $15,050, in 1913 to 1,143 tons, valued at $25,187, in 1914. Mines in Marion, Boone, and Newton counties produced all the zinc concentrates sold in 1914, and 80 per cent of the galena concentrates sold were mined in Newton County.

REVIEW BY DISTRICTS.

Dodd City and Jimmie Creek district.—The producing mines in this district in 1914 were the Lost Bell, Markle, North Star, Onwatta, and Pilot Rock. The output was mainly of zinc carbonate. The Beatty, Governor Eagle, and Nakomis mines were not operated in 1914.

Rush and Buffalo River districts.—The mines in these districts produced nearly all the mixed sphalerite and zinc carbonate concentrates and about one-half of the zinc carbonate concentrates shipped from Arkansas in 1914. The largest production was made by the Morning Star-Smuggler mine leased by J. Conness Shepherd. The 150-ton mill on the property was operated partly on the accumulation of fine dirt taken out while mining lump carbonate in 1913. This property was the largest producer of zinc concentrates in Arkansas in 1914. Another large producing mine was the Sure Pop mine on Water Creek, southwest of Rush, developed in the fall of 1914 by J. Conness Shepherd. The output of hand-cobbed carbonate obtained while running a 300-foot tunnel was shipped from Gilbert on the Missouri & North Arkansas Railway. The old Mohawk 50-ton mill was purchased and moved to the property to be used in milling the large quantity of fine dirt developed while mining the lump carbonate ore. Among the smaller producing mines in 1914 were the Bonanza and the Monte Cristo.

Zinc and Sugar Orchard districts.—The mines in the districts near Zinc are partly in Boone County and partly in Marion County. The production of concentrates from these districts shipped from Zinc was not so large in 1914 as the output from the Rush district, but more mines were worked and more money expended on development work. Although several concentrating plants were operated, most of the concentrates shipped were of hand-cobbed zinc carbonate obtained by means of tunnels driven into the hillsides. The most prominent operator was L. L. Brown, who shipped concentrates from ores mined at the Almy, Barham, Frisco, Cantrill, Houck, Coker Hollow, and Coon Hollow mines. The Jack Pot Mining Co., on land of the Earl Mining & Smelting Co., erected a 150-ton concentrating plant, which was operated for a short time late in the year. The ore treated was obtained by a tunnel driven into the hill. Much surface equipment was installed, some drilling was done, and a shaft is being sunk. The sphalerite concentrates sold were high grade. The Broome County Mining Co. also did some prospect drilling, installed a Sullivan compressor, and operated the 200-ton milling plant for a brief time. The surface equipment and the concentrating plant at the Iola mine were overhauled and new roads were constructed, but the mill was only in operation for a few days. The owners are preparing to sink a shaft. A small 50-ton mill was erected in December, 1914, by W. H. Almy. The mill has a crusher, rolls, and a rougher, and the concentrates are then cleaned on hand jigs. The Tar Kiln mine, which is equipped with a milling plant, produced no concentrates in 1914, but a shaft was being sunk at the mill and other development work has been undertaken following prospect drilling. A shaft was being sunk on the Madison mine near Zinc, and surface development work was done on the Milum mine near Pyatt. The only reported output of lead concentrates was from the land of the Washington Mining Co.

Ponca district.—The only productive mine was that of Whiteley & Kilgore on the Baker land, which produced nearly 80 per cent of the galena concentrates shipped from Arkansas in 1914.

Cave Creek district.—The J. R. Underwood lease on land of the Granby Mining & Smelting Co. made a fair yield of zinc carbonate. The mine is developed by means of a 60-foot shaft and a 100-foot tunnel, and the dirt is concentrated by means of hand jigs.

ILLINOIS.

By J. P. Dunlop.

PRODUCTION.

The production of silver, lead, and zinc in Illinois in 1914 is shown in the following table:

Mine production of lead and zinc in Illinois in 1914, in short tons.[a]

District.	Ores.					
	Lead concentrates (galena).		Zinc concentrates.			
			Sphalerite.		Zinc carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Northern Illinois	646	$28,778	16,725	$320,012	.....	.....
Southern Illinois	308	12,316	.....	.....	.....	.....
Total, 1914	954	41,094	16,725	320,012	.....	.....
Total, 1913	1,260	63,871	8,148	156,664	120	$1,603
Total, 1912	1,661	86,497	13,464	367,537	.....	.....
Total, 1911	1,269	62,425	11,011	320,806	.....	.....
Total, 1910	524	24,319	9,871	249,496	.....	.....
Total, 1909	372	19,122	5,206	165,099	.....	.....
Total, 1908	575	24,678	4,468	101,850	.....	.....
Total, 1907	1,117	61,628	2,530	37,728	.....	.....

District.	Metal content.			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Northern Illinois	492	$38,376	4,811	$490,722
Southern Illinois	225	17,550	.....	.....
Total, 1914	717	55,926	4,811	490,722
Total, 1913	959	84,392	2,236	250,432
Total, 1912	1,282	115,380	4,065	560,970
Total, 1911	964	86,760	4,219	480,966
Total, 1910	373	32,824	3,549	383,292
Total, 1909	295	25,370	2,103	233,604
Total, 1908	399	33,516	1,717	161,398
Total, 1907	830	87,980	737	85,966

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Mine production of silver in southern Illinois, 1907–1914.

	Silver.		Lead concentrates, silver bearing.	
	Quantity.	Value.	Quantity.	Ounces of silver per ton.
	Fine oz.		*Short tons.*	
1907	2,852	$1,882	497	5.74
1908	2,051	1,087	359	5.71
1909	1,011	526	259	3.90
1910	2,022	1,092	398	5.08
1911	3,036	1,609	482	6.25
1912	4,731	2,909	748	6.31
1913	3,541	2,139	507	7.00
1914	2,112	1,168	308	6.86

Tenor of lead and zinc ore and concentrates produced in Illinois, 1913 and 1914.

	1913	1914
NORTHERN ILLINOIS.		
Total crude ore.....short tons..	119,200	261,300
Total concentrates in crude ore:		
Lead.....per cent..	0.6	0.25
Zinc.....do....	6.9	6.4
Metal content of crude ore:		
Lead.....do....	.5	.19
Zinc.....do....	2.4	2.3
Average lead content of galena concentrates.....do....	78.1	76.2
Average zinc content of sphalerite concentrates.....do....	34.8	36.5
Average zinc content of zinc carbonate concentrates.....do....	29.5	.....
Average value per ton:		
Galena concentrates	$53.80	$44.70
Sphalerite concentrates	$19.23	$19.13
Zinc carbonate concentrates	$13.36	.....
SOUTHERN ILLINOIS.		
Average lead content of galena concentrates.....per cent..	73.3	73.5
Average value per ton of galena concentrates	$46.08	$39.99

The lead concentrates produced in southern Illinois are recovered in concentrating the fluorspar. To speak of the total crude ore raised as crude lead ore would be misleading. No attempt has been made, therefore, at calculating the quantity or the tenor of the crude ore.

The value of the mine production of silver, lead, and zinc in Illinois in 1914 was $547,816, as compared with $336,963 in 1913. The lead concentrate produced amounted to 954 short tons, which was 306 tons less than in 1913, and the recoverable lead content decreased from 959 tons in 1913 to 717 tons in 1914.

The output of sphalerite concentrate increased from 8,148 tons in 1913 to 16,725 tons in 1914, and the recoverable zinc content of the concentrates increased from 2,236 tons in 1913 to 4,811 tons in 1914, and the value was $240,290 more in 1914 than in 1913.

The silver recovered from lead concentrates amounted to 2,112 fine ounces, valued at $1,168, against 3,541 fine ounces, valued at $2,139, in 1913.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineralogical association and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

UPPER MISSISSIPPI VALLEY REGION.

In view of the fact that the history of lead and zinc mining in northern Illinois, southwestern Wisconsin, and southeastern Iowa has been closely interwoven since their earliest development, it is advisable to precede any review of the northern Illinois district with a general historical review of the upper Mississippi Valley lead and zinc region. Moreover, it is practically impossible to segregate the production of lead and zinc prior to 1907 so as to credit the several States with a separate production of lead and of zinc. The area in the region is defined as including Grant, Lafayette, and Iowa counties in Wisconsin, Jo Daviess County in Illinois, and an irregular narrow belt of territory in Clayton, Allamakee, and Dubuque counties parallel to Mississippi River in Iowa. The following is a historical sketch of the region written by H. Foster Bain,[1] of the United States Geological Survey:

The presence of important ore deposits in the upper Mississippi Valley early attracted attention to this region. The ease of travel along the Mississippi permitted its rapid exploration, and long before there was any regular settlement within its limits lead had become a regular article of commerce. It is improbable that the Indians knew anything of the smelting of lead ores or the use of lead until they were taught by the French. Since, however, French exploration of the region began with Nicolet's voyage of 1634, and the occurrence of lead ores was reported as early as 1658, there is no improbability in the statement that as early as 1690 [2] lead was purchased from the Indians by traders at Peoria. Yet it was a hundred years before white men settled in the region and took up regular mining. The history of these and the years immediately following has been summarized by Mr. Reuben G. Thwaites,[3] while Dr. O. G. Libby, assisted by F. Belle Stanton, Bernard M. Palmer, and Allard J. Smith,[4] has made a social and economic study of the lead region, based especially upon the history of the first half of the nineteenth century. To these sources in particular the reader desiring fuller historical details is referred. A brief statement only can be given here.

In the eighteenth century the region was practically given up to Indians and traders. The presence of ore deposits was well recognized, and the location of the mines was shown on many of the maps, such as that of Hennepin (1687), of William de l'Isle (1703), and of Guettard (1752). Lead was a regular article of commerce, purchased by traders at posts such as that of Nicholas Perrot, opposite the present site of Dubuque, and Le Gueur (1695), on an island farther up the river. These settlements were, however, essentially temporary, though M. le Guis in 1743 found 18 or 20 mines in operation along Fever River. In 1769 a concession for mining was granted at St. Louis to Martin Miloney Duralde, who seems, however, to have taken no advantage of it.

The first serious attempt made by white men to settle in the region for the purpose of mining was that of Dubuque. According to Schoolcraft,[5] to whom we are indebted for the first published account of the Dubuque mines, the discovery of lead at this point was made by the Indians themselves, as he states in the following paragraph:

"In 1780 a discovery of lead ore was made upon their lands by the wife of Peosta, a warrior of the Kettle Chief's village, and extensive mines have since been discovered. These were granted by the Indians to Julien Dubuque at a council held at Prairie du Chien in 1788, by virtue of which he settled upon the lands, erected buildings and furnaces, and continued to work the mines until the year 1810. In the meantime (1796) he received a confirmation of the Indian grant from the Baron de Carondelet, governor of Louisiana, in which they were designated the 'Mines of Spain.'"

Under Dubuque's régime several mines were opened, though it seems that no shafts were sunk. The ore was obtained by means of the hoe, shovel, crowbar, and pick from carelessly-protected drifts. Good roads were, however, built to the furnaces, one of which was erected near the mouth of Catfish Creek, where Dubuque had his

[1] Bain, H. Foster, Zinc and lead in upper Mississippi Valley: U. S. Geol. Survey Bull. 294, pp. 2–9, 1906.
[2] Senate Doc. No. 87, 29th Cong., 1st sess., 1846.
[3] Wisconsin Hist. Coll., vol. 13, pp. 271–292, 1895.
[4] Wisconsin Acad. Arts, Science, and Letters Trans., vol. 13, pp. 188–881, 1902.
[5] Schoolcraft, H. R., Narrative journal of travels, p. 348, Albany, 1821.

house in Kettle Chief's village. It is stated that up to recent years the sites of two of Dubuque's furnaces were well known—one on Eagle Point Avenue, near Heebs's brewery, and the other between Main Street and the river. Hon. M. M. Ham [1] has given a graphic account of Dubuque and of his life among the Indians. While Dubuque's concession covered only certain lands west of the Mississippi, he seems to have also carried on considerable trade in ore mined by the Indians east of the river.

A visit to Dubuque was one of the objects of Lieut. (later Gen.) Pike's expedition up the Mississippi in 1805. He found M. Dubuque "polite, but evasive," and did not visit the mines, although there is an interesting statement, signed by Dubuque and Pike in 1805, in which it is declared that 20,000 to 40,000 pounds of lead were made per annum, that being a yield of 75 per cent. It is also stated that copper had at that time been noticed, although no attempt had been made to reduce it.

After Dubuque's death the Indians burned his house and fences and destroyed all traces of civilized life. They continued, however, to work the mines intermittently, selling the ore to certain Indian traders who had furnaces located on islands in the river. One of these was owned by George E. Jackson and was on the Illinois side of the river, about opposite the mouth of Catfish Creek. For a decade following Dubuque's death the mines seem to have been practically abandoned to the Indians. In 1810, Nicholas Boilvin, Indian agent, reported that they could produce about 400,000 pounds of metal. In 1815, about 20 crude furnaces were said to be in operation by the Indians in the vicinity of the present site of Galena alone.

In 1819, the influx of white men into the region began with the establishment of Shullsburg by Jesse W. Shull, under military protection, and in 1823, Col. James Johnson began operations on a considerable scale at Galena. With the exception of the period of the Black Hawk war, settlement and development of the area proceeded rapidly from that time till 1850, when the discovery of gold in California and a series of other causes turned the tide of immigration farther west.

In Iowa settlement was held back till 1833, owing to delay in the extinguishment of Indian titles and the determination of the General Government not to recognize the title of Dubuque's heirs. In 1830, under the leadership of J. L. Langworthy and having previously obtained consent of the Indians and the Dubuque heirs, certain miners from Galena crossed the river and began work. It is said that the Langworthy crevice on Eagle Point Avenue, still occasionally worked, was located at this time.

The Government held, however, that the country was not yet open to settlement. Troops from Prairie du Chien drove out the miners and burned their cabins and for some years yet the Iowa mines were worked by the Indians. Schoolcraft [2] in 1820 made a canoe voyage from Prairie du Chien to the present site of Dubuque, at that time known as the Kettle Chief's village. The main workings then seem to have been west of the river, although Schoolcraft enumerates, in addition to the Dubuque mines, the "Sissinaway mines" and the "Mine au Fevre," the former the prototype of the Wisconsin mines and the latter the earliest workings at Galena. What are known as the Durango diggings then passed under the name of the mine of Maquanquitons. Schoolcraft's description, the first which we have of the mines of Dubuque proper, is as follows:

"The district of country generally called Dubuque's lead mines embraces an area of about 21 square leagues, commencing at the mouth of the Little Maquanquitons River, 60 miles below Prairie du Chien, and extending along the west bank of the Mississippi 7 leagues in front by 3 in depth. The principal mines are situated on a tract of 1 square league, commencing immediately at the Fox village of the Kettle Chief and extending westward. This is the seat of the mining operations formerly carried on by Dubuque, and of what are called the Indian diggings. The ore found is the common sulphuret of lead, with a broad foliated structure and high metallic luster. It occurs massive and disseminated, in a reddish loam, resting upon limestone rock, and sometimes is seen in small veins pervading the rock, but it has been chiefly explored in alluvial soil. It generally occurs in beds or veins which have no great width, and run in a certain direction 300 or 400 yards, then cease, or are traced into some crevice in the rock having the appearance of a regular vein. At this stage of the pursuit most of the diggings have been abandoned and frequently with small veins of ore in view. No matrix is found with the ore, which is dug out of the alluvial soil, but it is enveloped by the naked earth, and the lumps of ore are incrusted by an ocherous earth. Occasionally, however, some pieces of calcareous spar are thrown out of the earth in digging after lead, and I picked up a solitary specimen of the transparent sulphate of barytes, but these substances appear to be very rare. There is none of the

[1] Annals of Iowa, 3d ser., vol. 2, pp. 329–344, 1896.
[2] Schoolcraft, H. R., Narrative journal of travels, Albany, 1821.

radiated quartz, or white, opaque, heavy spar, which is so common at the Missouri mines. The calcareous rock upon which this alluvial formation, containing lead ore, rests, appears to be referable to the transition class. I have not ascertained its particular extent about the mines. The same formation is seen, overlain by a distinct stratum of compact limestone containing numerous petrifactions, at several places between the mines and Prairie du Chien. The lead ore at these mines is now exclusively dug by the Fox Indians and, as is usual among savage tribes, the chief labor devolves upon the women. The old and superannuated men also partake in these labors, but the warriors and young men hold themselves above it. They employ the hoe, shovel, pickax, and crowbar in taking up the ore. These things are supplied by the traders, but no shafts are sunk, not even of the simplest kind, and the windlass and buckets are unknown among them. They run drifts into the hills so far as they can conveniently go without the use of gunpowder, and if a trench caves in it is abandoned. They always dig down at such an angle that they walk in and out of the pits, and I descended into one of these which had probably been carried down for 40 feet. All this is the work of the Indian women and old men, who display a degree of perseverance and industry which is deserving of commendation. When a quantity of ore has been gotten out it is carried in baskets by the women to the banks of the Mississippi and then ferried over in canoes to the island, where it is purchased by the traders at the rate of $2 for 120 pounds, payable in goods. At the profits at which these are usually sold it may be presumed to cost the traders 75 cents to $1, cash value, per hundredweight. The traders smelt the ore upon the island, in furnaces of the same construction used at the lead mines of Missouri and observe that it yields the same per cent of metallic lead. Formerly the Indians were in the habit of smelting their ore themselves upon log heaps, by which a great portion was converted into what are called lead ashes and thus lost. Now the traders induce them to search about the sites of the ancient fires and carefully collect the lead ashes, for which they receive $1 per bushel delivered at the island, payable in merchandise."

The final opening of the country took place in 1833. Dr. A. G. Leonard has summarized the circumstances as below:[1]

"At the close of the Black Hawk War the large tract known as the Black Hawk purchase, including one-third of the present area of Iowa, was ceded to the United States by the Sacs and Foxes. After the completion of the treaty negotiations the miners again crossed over into the coveted region, where they built cabins and commenced to take out much ore. But a second time they were forced to leave because the treaty had not been ratified. In June, 1833, the treaty went into effect and the way was at length clear for settlers to take possession of the land. During the next few years large numbers flocked in, prospecting was actively carried on, and many mines were soon in operation.

"The first 'legislation' in Iowa dated from 1830. In June of that year a number of miners met on the banks of the Mississippi and enacted regulations to govern them in their relations to each other. One of the articles was that 'every man shall hold 200 yards square of ground by working said ground one day in six.' Much other interesting history clusters around these mines, but it is foreign to our purpose to go into that phase of the subject here."

For a quarter of a century the policy of government ownership of mines was tried. Under act of Congress of March 3, 1807,[2] the mineral lands of this district, as well as 68 sections in southern Illinois and a few townships in northern Arkansas, were reserved from sale with the provision that they should be leased on an annual rental. In the Galena district the reserved holdings amounted to 345,600 acres, in Iowa to 184,320 acres, and in Wisconsin to 1,428,480 acres. No leases seem to have been ever granted in Arkansas. A few only, beginning with one in 1809 issued by the governor of Indiana, were granted in southern Illinois, but in the upper Mississippi Valley the system was carried out for some years. The lands were at first under charge of the Treasury Department, but in 1821 were transferred to the War Department. A superintendent of mines, with suitable assistants, was employed and a royalty of one-sixth to one-tenth, payable in lead or cash, was exacted. The first lease at Galena was taken by Col. James Johnson in 1823, and in 1846, 2,093 leases had been granted, of which 518 were outstanding. The system early provoked opposition and much friction ensued. Very few leases were ever taken in Iowa, the local courts being decidedly antagonistic to the system. In 1846, when it was abolished, a total return of $145,174.40 had been realized between 1841 and 1845, while it had cost $68,464.50[3] directly to collect the rents, and a considerable additional sum had been spent in litigation. It was therefore decided to sell the lands.

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[1] Iowa Geol. Survey, vol. 6, p. 16, 1896.
[2] Laws U. S., vol. 4, p. 127.
[3] S. Ex. Doc. No. 87, 29th Cong., 1st sess., 1846.

Preliminary to this a survey was ordered in 1839 and placed in charge of that pioneer geologist, D. D. Owen. This survey was in many particulars unique. Owen began field work in September and, with the aid of a large number of assistants, finished it before winter. A report, accompanied by maps, sections, figures, descriptions, and fossils, was submitted to the Land Office on April 2 following. This report [1] was printed without illustrations in June of the same year, and a revised edition, including the omitted plates, was printed in 1844.[2] In this survey a large area, including the whole of the mining section, was traversed township by township, and the character of the rocks was noted. In 1847 Owen executed for the Treasury Department another survey of the Chippewa land district, and in his report [3] on that region gives certain additional details regarding the lead and zinc region.

In the course of a still later survey he visited the region again, and in his well-known quarto report he briefly discusses the geological formations present.[4] Owen was accordingly the first geologist of note who studied the region in detail, and his conclusions, based as they were upon a long and intimate acquaintance with it, are worthy of the utmost respect. It is curious to note, however, that he entirely overlooked the Maquoketa shale and confused the Galena and Niagara; and it can be readily believed that in this, as well as in his opinions respecting the deep-seated origin of the ore deposits, he was misled by the ideas then currently accepted.

In 1854 J. D. Whitney published his Metallic Wealth of the United States.[5] Having made certain investigations in the region in the course of private professional work, he gave a very accurate though brief account of the mines. His ideas were later elaborated in the course of his work for the three States, Iowa, Wisconsin, and Illinois, for which he successively studied the field. In his reports he covered the whole ground excellently, and it is no disparagement to others to say that together they form the most complete account of the field yet published.[6]

Prof. Whitney visited the region in the years of the maximum importance of the lead mines and his observations are accordingly particularly valuable. It was, however, after his work was finished that zinc became of value in the region. Industrial conditions have also largely changed, so that there now is much of interest to be added to his report.

Aside from Whitney and Owen, the best known of the earlier investigators in this region was J. G. Percival, who made a study of the lead region for the State of Wisconsin in 1854 and 1855. Accuracy of observation is everywhere characteristic of Percival's work, but his conclusions as to the origin of the ores and the best methods of working them seem to have been unfortunate.[7] Like Owen, he followed the current theory of the period.

The later Wisconsin survey renewed the study of the region, and in the elaborate papers of Moses Strong [8] and T. C. Chamberlin [9] we have the most detailed study of the region extant, with, in the latter case, a notable addition to the discussion of the theoretic considerations involved.

About 1893 attention was again attracted to the soft-lead deposits of the Mississippi Valley, and a few years later the zinc ores of the region became properly appreciated. The most notable resultant contribution to the literature of the subject was the report on the lead and zinc deposits of Missouri by Winslow and Robertson [10] published in 1894. Although nominally devoted to the Missouri field the report covers practically the whole subject, and contains very full notes on the upper mines, but nothing original concerning the latter field. The meeting of the International Engineering Congress at Chicago in 1893 and the reading there of Posepny's famous paper on the origin of ore deposits led directly and indirectly to the publication of a number of papers in which the phenomena of the region are discussed. Among the more important of these and others of the same period are those of Posepny, Jenney, Blake,[11] Win-

[1] H. Ex. Doc. No. 239, 26th Cong., 1st sess., 161 pp., Washington, 1840.
[2] Rept. Geol. Expl. Iowa, Wisconsin, and Illinois in 1839, Washington, 1844.
[3] S. Ex. Doc. No. 57, 30th Cong., 1st sess., 134 pp., Washington, 1848.
[4] Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, 638 pp., Philadelphia, 1852.
[5] Philadelphia, Lippincott, Grambo & Co., 1854.
[6] Geol. Survey Iowa (Hall), vol. 1, pp. 286–295, 422–471, Albany, 1858. Geology of Wisconsin (Hall), vol. 1, pp. 73–424, 1862. Geology of Illinois, vol. 1, pp. 153–207, Springfield, 1866.
[7] Percival, J. G., Wisconsin Geol. Survey Ann. Rept., 101 pp., 1855. Wisconsin Geol. Survey Second Ann. Rept., 111 pp., 1856.
[8] Geology of Wisconsin, vol. 2, pp. 643–752, 1877.
[9] Idem, vol. 4, pp. 365–571, 1882.
[10] Lead and zinc deposits, by Arthur Winslow, assisted by James B. Robertson: Missouri Geol. Survey, vols. 6 and 7, Jefferson City, 1894.
[11] Posepny, Franz, Am. Inst. Min. Eng. Trans., vol. 23, pp. 197–369, 1894; vol. 24, p. 96, 1895.
Jenney, W. P., idem, vol. 22, pp. 171–225, 1894.
Blake, W. P., idem, vol. 22, pp. 558–568, 569–574, 621–634, 1894; vol. 23, p. 587, 1894; Geol. soc. America Bull., vol. 5, pp. 25–32. Wisconsin Acad. Sci., Arts, and Letters Trans., December, 1892; Am. Geologist, vol. 12, pp. 237–248, 1893.

slow, Robertson, Chamberlin, and Roethe.[1] The organization of the Iowa Geological Survey in 1892 and of the Wisconsin Geological and Natural History Survey in 1899 has permitted a rather thorough restudy of the region. * * *

It is possible to arrive at fairly accurate figures of the past production of the district as regards lead, but the total zinc production is much less accurately known. Strong gives the following estimates of the lead production of the region:[2]

Estimated production of lead in upper Mississippi Valley, 1821–1871, by decades.

	Short tons.
1821–1831	23,244
1832–1841	55,718
1842–1851	215,979
1852–1861	161,334
1862–1871	84,700
Total	538,975

For the decade 1872 to 1881, the production may be estimated from various sources[3] as amounting to 49,000 tons. After 1880 the production was very small, probably averaging less than 1,000 tons a year up to 1900, at which time the recent revival in mining began.

If the production be estimated at 1,000 tons a year for the entire period up to 1904, the result probably would not be far wrong. The total production would then be as follows:

Estimated production of lead in upper Mississippi Valley, 1821–1904, by periods.

	Short tons.
1821–1871	538,975
1872–1881	49,000
1882–1904	24,000
Total	611,975

It is less easy to get at the value of this metal, but it will probably be safe to say that it sold for approximately $50,000,000. The maximum production, it may be noted, was between 1840 and 1850. In 1845 and again in 1847 more than 27,000 tons of lead were shipped.

There was no market for zinc ore prior to 1860. In that year the La Salle smelter began to run, and in succeeding years the oxide furnaces at Mineral Point, Wis., the smelters at Waukegan and Peru, Ill., and at various points in Indiana were built, and sent buyers into the region.

Strong[4] has given detailed figures of the production up to 1876. The total amounted to 69,467 tons of carbonate and 57,728 tons of blende. The output of succeeding years is less accurately known, but from the best available data it has been roughly estimated that up to 1904 approximately 425,000 tons of zinc ore had been sold.[5] In 1904 the output was estimated at 19,300 tons.[6] This estimate appears now to have been somewhat too low, and it will probably be conservative to estimate the total production up to 1905 at 450,000 tons, though no great accuracy can be claimed for this figure.

The early prices paid for the ore were very low—$3 to $8 for the carbonate and $4 to $12 for the blende. In recent years the product has been entirely blende, which has sold for much better prices. Nevertheless, it is probable that up to 1905 the total zinc sales of the district had not greatly exceeded $10,000,000 in amount.

The early statistics give the output of lead metal (not ore) and of zinc concentrates (not spelter). In order to give an approximate idea of the total quantity of lead and of zinc concentrates recovered

[1] Winslow, Arthur, Am. Inst. Min. Eng. Trans., vol. 23, pp. 528–529, 1894; Jour. Geology, vol. 1, pp. 612–619, 1893.
Robertson, J. D., Am. Geologist, vol. 15, pp. 235–248, 1895.
Chamberlin, T. C., Geol. Soc. America Bull., vol. 5, p. 32, 1894.
Roethe, A. J., Eng. and Min. Jour., vol. 61, pp. 88–89, 1896.
[2] Geology of Wisconsin, vol. 2, p. 750, 1877.
[3] Winslow, Arthur, Missouri Geol. Survey, vol. 6, pp. 147–148, 1894.
[4] Strong, Moses, Geology of Wisconsin, vol. 2, pp. 742–743, 1877.
[5] U. S. Geol. Survey Bull. 246, p. 13, 1905.
[6] U. S. Geol. Survey Bull. 260, p. 265, 1904.

in the region the figures given in the preceding tables are supplemented by estimates for 1905 and 1906. With these additions the total quantity of metalic lead 1821–1906, inclusive, amounted to 616,570 tons, valued at $50,483,830, and the zinc concentrates produced up to and including the year 1906 amounted to 522,600 tons, valued at $11,452,000. Since 1907 the mine figures for both concentrates and metal have been collected by the Survey and are given in the following table:

Production of lead and zinc in the upper Mississippi Valley region, 1907–1914, in short tons.

Year.	Concentrates.				Metal.			
	Lead.[a]		Zinc.[b]		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	5,332	$322,101	53,149	$1,083,864	4,202	$445,412	19,372	$2,285,796
1908	5,525	292,190	56,658	1,160,346	4,363	366,492	20,318	1,909,892
1909	4,817	265,484	75,857	1,735,954	3,818	330,284	25,350	2,737,800
1910	5,759	294,662	104,617	2,075,398	4,534	398,992	29,572	3,193,776
1911	5,221	274,435	110,009	2,324,072	4,038	363,420	33,939	3,869,046
1912	4,315	232,408	120,451	3,349,229	3,331	299,790	37,115	5,121,870
1913	3,367	169,856	106,931	2,242,377	2,519	221,672	32,346	3,622,752
1914	2,674	113,974	128,047	2,282,174	1,986	154,908	35,924	3,664,248
Total	37,010	1,965,110	755,719	16,253,414	28,791	2,580,970	233,936	26,405,180

[a] Includes galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.

The preceding table shows that the lead produced amounted to 28,791 tons, valued at $2,580,970, which, added to the estimated output from 1821 to 1906, inclusive, gives an estimated total output of metallic lead for the region up to and including the year 1914 of 645,361 tons, valued at $53,064,800. The decline in output of lead is shown by the small production of 1,986 tons in 1914 compared with an estimated output of 27,000 tons in 1847. Conversely, the increasing importance of the production of zinc is indicated by an increase in the yield from an estimated output of 33,000 tons of concentrates in 1905 to more than 128,000 tons in 1914. If the estimated output of zinc concentrates prior to 1907, amounting to 522,600 tons, valued at $11,452,000, is added to the production of 755,719 tons, valued at $16,253,414, for the years 1907–1914, inclusive, a total yield of 1,278,319 tons of zinc concentrates, valued at $27,705,414, is shown for the region up to the end of 1914. As neither the quantity nor the average zinc content of the carbonate or sphalerite concentrates included in the estimate of production for the years prior to 1907 are known, it is impossible to give more than the crudest estimate of the total recoverable spelter contained in the concentrates. The only available estimate that can be made, based on the data obtained for the period 1907 to 1914, indicates a total spelter output for the region up to the end of 1914 of 395,700 tons. This quantity, estimated at an average price of $100 a ton, is valued at $39,570,000. As the estimated value of the lead output is $53,064,800, the total value of the lead and zinc produced in the region has been about $92,000,000.

NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwest county of the State. The ores have the same structural relations as in the upper Mississippi district generally; that is, they occur disseminated through the limestone, or in openings in it called "crevices," "pitches," or "flats," depending on their attitude to the horizontal. These openings have, in general, an east and west trend, known as their "range." The ore bodies are sometimes continuous for long distances along these "ranges," which for that reason largely control the prospecting, both by shafts and by drilling. The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age.

The ores are galena, smithsonite, and sphalerite, though the two latter are much less common now than formerly, when the deposits worked were mostly shallow and above water level. In early years the galena ores only were mined and the ore was taken from shallow pockets in quantities ranging from a few tons to several thousand.

Although the lead output of northern Illinois, Wisconsin, and Iowa has been large in the past and the ores have been smelted near the mines,[1] the output in recent years has been comparatively small and no ores have been smelted in those States.[2] The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Iron pyrites is very commonly associated with the ores, frequently in such quantity as to necessitate roasting and magnetic separation. None of the concentrating plants have calciners or roasters and magnetic separators attached. There are several separating plants operated near by in Wisconsin, including the Campbell plant of the Wisconsin Separating Co., at Cuba City; the National Zinc Separating Co., at Cuba City; the Wisconsin Separating Co., at Benton; the Mineral Point Zinc Co., at Mineral Point; the Linden Zinc Co., at Linden, and the Vinegar Hill Zinc Co., at Platteville.

As none of the operators in the Sand Prairie district or in the Elizabeth district reported any production in 1914 the entire output of northern Illinois is included under the Galena district. The production of lead concentrates was 646 tons, valued at $28,778, as compared with 753 tons, valued at $40,509 in 1913.

There were 16,725 tons of sphalerite concentrates, valued at $320,012, produced in 1914, an increase of 8,577 tons in quantity and of $163,348 in value, or practically double the output of 1913. The average price per ton received for sphalerite concentrates was about the same as in 1913.

The tonnage of crude ore mined increased from 119,200 tons in 1913 to 261,300 tons in 1914. The zinc concentrates in the ore milled showed a decrease of 2.5 per cent, and the percentage of lead was less than one-half that of 1913.

The average zinc content of the sphalerite concentrate increased from 34.8 per cent in 1913 to 36.5 per cent in 1914.

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[1] Cox, G. H., Lead and zinc deposits of northwestern Illinois: Illinois State Geol. Survey Bull. 21, p. 14, 1914.

[2] Pulsifer, H. B., History of lead smelting in Wisconsin: Min. and Eng. World, May 2, 1914, p. 821.

REVIEW BY DISTRICTS.

Sand Prairie district.—The old Royal Princess mine, which had been idle for several years, was leased late in 1914 by the Pittsburg Zinc Mining Co., and preliminary work was undertaken prior to pumping out the water and resuming underground development.

Galena district.—The Galena district includes the mines in the vicinity of Fever River from Mississippi River to the Wisconsin State line. For many years the principal production was of lead ores, but in recent years the zinc output has increased to such an extent that the lead is of minor importance. In 1907 the yield of zinc concentrates amounted to only 2,530 tons; in 1914 the output was 16,725 tons, the largest recorded output of the district and exceeding that of 1912 by more than 3,000 tons.

The largest production of lead and zinc concentrates in northern Illinois in 1914 was derived from the old Marsden-Black Jack mine of the Mineral Point Zinc Co. This mine was reopened and a mill was constructed late in the year 1913. The mill was steadily operated during 1914 on dirt obtained by means of two shafts, one of which is 200 feet and the other 250 feet deep. The second largest producing mine was the Pittsburg, operated by the Great Western Lead Manufacturing Co. A 100-ton concentrating plant was completed in February, 1914. The shaft at the mine is 138 feet deep. The output of the Northwestern mine again increased. This mine is on the Stacey land, has a 100-foot shaft, and is equipped with a 100-ton mill.

A large output was made at the old Vinegar Hill mine before the ore body was exhausted and the mill removed. Anticipating the abandonment of this property the Vinegar Hill Zinc Co. prospected the Curran land with drills and developed a new mine, the North Unity. A 150-ton mill and other equipment was installed and a shaft was sunk. The first concentrates were produced in October, and the outlook for a continued large production is favorable. No work was done on the Hughlett & Gray or on the Lake Superior properties other than some prospect drilling. The Josephine Mining Co. on the Doolin land were sinking a shaft and doing other development work. The output of the mine was entirely galena concentrates. The Merry Widow and the White Rose mines were acquired by the Mid West Mining Co. Five new shafts were being sunk and the production was very small. The Merry Widow has been a large producer of galena and is equipped with a 100-ton mill. The Easy Hit mine on the Dankbar land was being developed by G. E. Brown, but no concentrates were sold in 1914.

SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of Mississippian age in the northern extension of the Kentucky-Illinois fluorspar district. The first discovery was made near Rosiclare in a well on the Anderson property,[1] now owned by the Fairview Fluorspar & Lead Co. The first attempt at mining was begun in 1842 on the Pell or Rosiclare vein.[2] Desultory

[1] Worthen, A. H., Illinois Geol. Survey, vol. 1, pp. 350-375, 1866.
[2] Ulrich, E. O., and Smith, W. S. T., The lead and fluorspar deposits of western Kentucky: U. S. Geol. Survey Prof. Paper 36, 1905.

operations continued for several years until the Good Hope shaft of the Fairview Fluorspar & Lead Co. was begun in 1862. From that year until 1874 the work was practically continuous, the ore being smelted as well as mined on the property.[1] Three smelters were built, two of which were destroyed by fire and the other was removed about 25 years ago. The total production from the Fairview, the Rosiclare, and other mines which have been operated many years is unknown. The principal product of the mines in recent years has been fluorspar, and the yield of galena is small compared with the output from other districts in the Central States. The total production of galena concentrates for southern Illinois, 1906–1914, inclusive, has been 4,037 tons, most of which has been shipped from the Fairview and Rosiclare mines. The shipments of zinc ores from the district have been comparatively small and scattered. The only recorded shipments of zinc carbonate were made from the Empire mine in 1903 or 1904, and in 1906 four companies made shipments aggregating 103 tons.

The structural relations and the mineralogic association are similar to those of the deposits of western Kentucky and in striking contrast to those of the deposits of northern Illinois. The ores occur in fissure veins, in association with jointing and faulting. The mines have been worked to depths of 300 and 500 feet without disclosing any decrease in the dimensions of the ore bodies. Dikes and sheets of lamprophyre and dikes of mica peridotite occur in the vicinity, but not in direct connection with the ore deposits. Galena is the most important metallic mineral. Formerly, and nearer the surface, large bodies of galena were worked, but it is at present produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the tonnage of crude ore. As the district is not reached by railway, the product of the mines is dependent on river transportation.

The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, the silver content ranging up to 12 and 14 fine ounces per ton of lead concentrates, and averaging for the last five years from 4 to 7 fine ounces per ton of lead concentrates. Sphalerite, or zinc blende, is the next important metallic mineral, but it occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last six years. The principal vein minerals are fluorspar, calcite, and barite.

The shipments of galena concentrates decreased 199 tons in quantity, and the silver content recovered in treating the concentrates decreased from 3,541 ounces in 1913 to 2,112 ounces in 1914. The average lead content of the concentrates increased from 73.3 per cent in 1913 to 73.5 per cent in 1914. The average silver content per ton recovered from lead concentrates, which was only 3.90 fine ounces in 1909, increased from 6.31 in 1912 to 7 ounces in 1913 and 6.86 ounces in 1914. The steady yearly increasing recovery of silver per ton of concentrates apparently indicates that the galena recovered from fluorspar mined at the lower levels contains the greater silver content.

[1] Bain, H. Foster, The fluorspar deposits of southern Illinois: U. S. Geol. Survey Bull. 255, p. 44, 1905.

The decreased output of galena concentrates was caused by the lower value of the concentrates and the decreased mining of fluorspar occasioned by the poor demand for fluorspar to be used as a flux.

The Fairview Fluorspar & Lead Co. operates on the Good Hope vein, which was first developed in 1862. The workings in 1913 were reached by three shafts, of which the Good Hope is 505 feet deep; No. 4, 281 feet deep; and Blue Diggings, 400 feet deep. Nearly three-quarters of the fluorspar was mined from the Blue Diggings shaft at the 200-foot and 300-foot levels. This shaft was sunk from 200 feet to 400 feet. The remainder of the ore came from the 281-foot level of No. 4 shaft. A new shaft 6 by 16 feet was being sunk, which will be used for handling tools and timber and as a pump shaft. The concentrating plant at the mine has a capacity of 200 tons.

The Rosiclare Lead & Fluorspar Co., which is the largest producer of fluorspar and lead concentrates in southern Illinois, operates on an ore body which is probably continuous with that of the Fairview. The workings have reached a depth of 300 feet, and the mine has a long record of continuous production. The steel and concrete mill, entirely fireproof, is designed to handle 500 tons a day, and is provided with special facilities for saving the lead and zinc.

IOWA.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Iowa in 1907–1914 is shown in the following table:

Production of lead and zinc in Iowa in 1907–1914, in short tons.[a]

District.	Ores.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Dubuque:										
1914										
1913	83	$4,150					65	$5,720		
1912	78	3,900					63	5,670		
1911	75	3,750					60	5,400		
1910	25	1,320	245	$5,740			20	1,760	96	$10,368
1909	45	2,079			100	$1,500	36	3,096	35	3,780
1908	63	3,613	829	23,183			51	4,284	395	37,130
1907	304	22,023	303	8,577			242	25,652	145	17,110

[a] In calculating the metal content of the ore from assays, allowance has been made for smelting losses in the case of zinc, but not in the case of lead. In comparing the value of ore and metal content it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles, in Dubuque, Clayton, and Allamakee counties. They are found in the Galena dolomite, of Ordovician age. The historical review of the upper Mississippi Valley region, of which Iowa is a part, is given in the Illinois chapter of this report. No separate

record of the total production of the lead and zinc in Iowa can be stated. The total zinc production of the State was a very small part of the total output of the region.

In early days the Dubuque mines were the most important source of lead in the United States, and in later years the mines, especially those in the vicinity of Durango, yielded considerable quantities of zinc carbonate ore. Nearly all this earlier mining was done above water level, and only within the last few years has there been much attempt to mine below water level. Therefore the production, particularly of zinc-blende ore for these years, though small, is noteworthy, since it represents the attempt to mine at deeper levels.

The ore deposits of the Dubuque district occur in crevices and in caves or "openings" along these crevices. Of these openings there are five or six, the "top," "middle," and "third" being the most prolific of ore. The "flats" and "pitches" common in the Wisconsin mines have been found in only one or two instances in Iowa. The crevices have an east-west trend and sometimes extend considerable distances, being mined at different places, in which case they are known as "ranges." The mining operations of recent years have generally been confined to attempts to find paying ore at deeper levels in these old ranges, which are known to have yielded ore in former days in the upper openings.

There was no production of either lead or zinc reported by Iowa mines in 1914. Most of the mining companies have ceased work and forfeited their charters. Some lead will probably continue to come from the small mines, but the present outlook is not favorable for any large yield of zinc.

KANSAS.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Kansas in 1914 is shown in the following table:

Production of lead and zinc in Kansas in 1914, by districts, in short tons.[a]

District.	Ores.							
	Lead concentrates.				Zinc concentrates.			
	Galena.		Carbonate.		Sphalerite.		Carbonate and silicate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Galena	1,701	$75,376	.....	.....	15,065	$566,173	38	$623
Lawton	107	4,600	.....	.....	6,747	264,003	.....	.....
State total:								
1914	1,808	79,976	.....	.....	21,812	830,176	38	623
1913	3,102	158,019	2	$43	20,033	793,034	198	3,194
1912	3,003	158,798	33	1,335	21,258	1,005,509	125	3,152
1911	3,621	197,852	.....	.....	20,287	734,148	122	2,916
1910	2,973	144,284	61	2,496	27,134	998,219	106	1,452
1909	1,680	81,728	.....	.....	22,840	884,283	503	8,215
1908	3,265	170,227	.....	.....	28,524	932,646	395	4,414
1907	3,192	182,603	8	303	35,871	1,444,723	94	489

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in the case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Production of lead and zinc in Kansas in 1914, by districts, in short tons—Continued.

District.	Metal content.			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Galena	1,327	$103,506	7,676	$782,952
Lawton	82	6,396	3,608	368,016
State total:				
1914	1,409	109,902	11,284	1,150,968
1913	2,427	213,576	10,088	1,129,856
1912	2,371	213,390	10,638	1,467,354
1911	2,859	257,310	10,272	1,171,008
1910	2,412	212,256	13,229	1,428,732
1909	1,300	111,800	11,445	1,236,060
1908	2,518	211,512	14,119	1,327,186
1907	2,555	270,830	17,772	2,097,096

Tenor of lead and zinc ore and concentrates produced in Kansas, 1913 and 1914.

	1913	1914
Total crude ore, short tons	590,300	540,500
Total concentrates in crude ore:		
Lead, per cent	0.5	0.33
Zinc, do	3.5	4.04
Metal content of crude ore:		
Lead, do	.4	.26
Zinc, do	1.9	2.32
Average lead content of galena concentrates, do	78.2	77.9
Average zinc content of sphalerite concentrates, do	55.7	57.4
Average zinc content of zinc silicate and carbonate, do	35.9	34.2
Average value per ton:		
Galena concentrates	$50.94	$42.02
Sphalerite concentrates	$39.58	$38.06
Zinc silicate and carbonate	$16.13	$16.40

The lead and zinc deposits of Kansas, so far as developed, are limited to the southeastern portion of the State, in Cherokee County. They comprise the western extension of the ore deposits of the Joplin region and display the general characteristics of that area, except that here typical sheet-ground deposits have not been extensively developed. The ores are galena and lead carbonate, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, carrying but a small fraction of an ounce of silver to the ton of lead concentrates.

During the period of discovery and first operations of the mines in the vicinity of Joplin small discoveries of lead ore were frequently made in Kansas.[1] In 1870 zinc ore was discovered on the Cook land near Galena, and about 1872 some zinc ore from the property was sold in Joplin. In the spring of 1876 lead ore was discovered on the Harper farm, on Shoal Creek, later known as the Bonanza. A shaft was sunk which revealed galena in quantity. Other discoveries made in the spring of 1877 on Short Creek resulted in a rush to the field and the beginning of mining operations which made Galena famous as a

[1] Haworth, Erasmus, and others, History, geography, geology, and metallurgy of Galena-Joplin lead and zinc: Kansas University Geol. Survey, vol. 8, 1904.

producer of lead and zinc ores. A large quantity of lead ore was produced during the next three years, but only a small quantity of zinc ore was shipped before 1881. In 1898 the Badger-Peacock camp, 5 miles north of Galena, was developed, which produced a large quantity of ore up to the last few years. The Lawton district, 3½ miles north of Badger-Peacock, was not prospected until 1900 and did not attain prominence as a producing camp until 1911. Since then its development has been constant and its production very large. The total production of lead and zinc concentrates in Kansas since 1877 has not yet been definitely ascertained. It is difficult to obtain the production for early years or to segregate the Kansas ores from those produced in the adjoining portion of the Joplin region in Missouri. If to the figures obtained and published by the State Geological Survey of Kansas for the years 1886-1903 [1] are added those for the years 1904–1914, published by the United States Geological Survey, a total output of 993,354 tons of zinc concentrates and of 145,604 tons of lead concentrates are shown as the approximate output of Kansas for the years 1886–1914, inclusive.

The value of the mine production of lead and zinc in Kansas in 1914 was $1,260,870, against $1,343,432 in 1913. Most of the decrease was caused by the decline in the average price of lead from $88 a ton in 1913 to $78 a ton in 1914. The decrease in the value of sphalerite concentrates in the Galena district was $72,700, but this loss was more than offset by an increase of about $120,000 in the value of the output of Lawton district. The value of the lead recovered in Kansas was $103,674 less in 1914 than in 1913. The production of lead concentrates decreased from 3,104 tons in 1913 to 1,808 tons in 1914. The total value of all lead concentrates was $78,086 less in 1914 than in 1913. The metal content of these lead concentrates shipped in 1914 was 1,409 tons, as against 2,427 tons in 1913. The percentage of lead concentrates in crude ore milled decreased from 0.5 per cent in 1913 to 0.33 per cent in 1914. The average lead content of the galena concentrates was only 0.3 per cent less in 1914 than in 1913, but the average price received for concentrates declined nearly $9 a ton.

The production of zinc carbonate and silicate amounted to 38 tons, valued at $623, which was 160 tons less than in 1913.

The production of sphalerite concentrates in 1914 was 21,812 tons, valued at $830,176, which was an increase of 1,779 tons in quantity and of $37,142 in value. With a smaller quantity of ore mined from the blanket ground in 1914 the proportion of sphalerite concentrates recovered from crude ore milled increased from 3.5 per cent in 1913 to 4.04 per cent in 1914. The quantity of crude ore treated decreased about 50,000 tons and the value of the sphalerite concentrates sold was only $1.52 per ton less than in 1913. The increase of 1.7 per cent in the average zinc content of the sphalerite was due to the larger proportionate quantity of high-grade concentrates from the Lawton district.

All Kansas districts considered, there was about as much prospecting done in 1914 as in 1913, and at the end of the year conditions were such that with higher ore prices the State production could be considerably increased. There were not many changes of ownership of mining lands at Galena, and, although several new mills were

[1] Haworth, op. cit., p. 105.

erected, mining operations, on the whole, were less extensive than in 1913. No mining was done in the Badger-Peacock district, but preparations were made late in the year to pump the water from the idle properties, which are said to contain considerable ore that could be profitably mined with the high prices for ore now prevailing. The Lawton camp was one of the most active in the Joplin region, and the increased output resulted from two of the many new mines attaining the producing stage. A considerable portion of the output of sphalerite credited to the Galena district came from outlying camps in the vicinity of Cave Springs and Klondike districts in Missouri but on the Kansas side of the line.

REVIEW BY DISTRICTS.

Badger-Peacock district.—The underground workings of the old mines in this district have been flooded since the spring of 1912. It was proposed to remove the United Lehigh mill from Carl Junction, Mo., to the camp and for the owners of the various mining tracts to cooperate in the heavy expense of draining the mines. Low prices for ore held back the consummation of this plan, and in consequence the only production the last few years has been that from tailings. The district has been a large producer of sphalerite, but the pumping expense was large and it will be necessary to rebuild the dikes along Spring River which were destroyed by a freshet in 1912.

Lawton district.—This district, which is situated 3½ miles north of Badger-Peacock and 14 miles northwest of Joplin, was first prospected about 1900, but did not attain prominence as a producing camp until 1911. The output doubled in 1912, again doubled in 1913, and the production in 1914 was equal to the combined output of the three previous years.

About 137,000 tons of ore were milled in 1914, and the shipments made were 107 tons of galena concentrates and 6,747 tons of sphalerite, having a total value of $268,603. The ore bodies are extensive and the ground requires timbering in some places. The dirt milled averages about 5 per cent in concentrates, and the zinc content of the sphalerite averages more than 59 per cent.

The productive leaseholds in 1914 were those of the Eastern Zinc & Lead Co., and the John A. Hall Mining Co. In addition to the production made by the mill owned by the Eastern Zinc & Lead Co., there were mills operated on the same land by the H. L. & S. Mining Co., and by the Lawton Mining Co., now called the Della A. Mining Co.

Numerous drill holes were sunk in 1914 by the Eastern Zinc & Lead Co., which indicated large bodies of ore at lower depths than those now mined, which are mostly at the 120-foot and the 140-foot levels. Two shafts were utilized to supply ore to the 200-ton mill in 1914 and a 204-foot shaft is used solely for pumping. The deepest shaft at the Eastern mine is down 213 feet and a drift has been run at the 175-foot level, but no ore was extracted therefrom in 1914. Shaft No. 5, which is located about 1,000 feet east of the mill, was completed late in the year, and a tramway is to be erected to convey the ore to the old concentrating plant, or a new mill of smaller capacity will be built to treat the ore. The H. L. & S. Mining Co. lease on Eastern land was sold late in the year to Chas. B. Poyntz and

others. Considerable drill prospecting was done, and the shaft was sunk from 140 feet to 170 feet. Complete electric equipment, new jigs, and tables were installed at the milling plant, which now has a capacity of 150 tons.

The Lawton lease and mill of 200 tons was taken over by a new company called the Della A. Mining Co. The lease was thoroughly prospected and the shaft was sunk to the 180-foot level. The mine produced considerable ore in 1914 and recent developments indicate a much larger output in 1915.

The only producing mine on the Ball land in 1914 was that of the John A. Hall Mining Co., which mined ore between the 130-foot and the 148-foot levels. The ore from this mine contained more lead than the ore from the mines developed to the north and west, so that more than half of the galena concentrates shipped in 1914 from the district were derived from this mine. Shafts were sunk on the A. J. Young and the Stapes & Co. subleases of the Hall lease. The Jeff & Mutt Mining Co. operated a prospect drill on the Ragland & James lease on the Ball land, which indicated good bodies of ore, and a 160-foot shaft was sunk and a drift run at the 151-foot level. A concentrating plant will be erected when a sufficient quantity of ore has been developed.

Galena district.—The production of lead concentrates in the Galena district in 1914 was 1,701 tons, valued at $75,376, as compared with 3,043 tons, valued at $154,761 in 1913. The shipments of zinc concentrates (all of which was sphalerite except 38 tons) were 15,103 tons, a decrease of 1,535 tons. Owing to the lower prices paid for the smaller output in 1914, the total value of the zinc concentrates was $75,271 less than it was in 1913. There was a decrease of 160 tons in the quantity of zinc carbonate and silicate, and there were no sales of lead carbonate in 1914. The metal content of the lead concentrates was 1,327 tons in 1914, against 2,380 tons in 1913.

There was no special activity in the district, operators being disinclined to undertake new development while ore prices were so low. The reduced production merely reflects the usual result of conditions and higher prices will result in a much increased output. Less ore was mined from the "blanket ground," and as such ground contains a larger quantity of lead than the disseminated ore bodies there was a sharp decline in the yield of galena concentrates in 1914, and the metal content of the lead concentrates showed a small decrease. There was the usual large percentage of output made by small operators who sell "dirt" to the chatters or mill it at custom concentrating plants. New ground was opened on the Galena Lead & Zinc Co. land by the Diplomat Mining Co. and on the Black Hills land by Fred L. Stone. The Maggie Taylor land was bought by S. R. Ping and after 15 holes were drilled a shaft was sunk and a 250-ton mill was erected, which was in operation the latter part of the year. The Joplin-Columbus mine on the Phebus land, near Cave Springs, produced a large output of the highest grade sphalerite concentrates shipped from Kansas. The ore occurs in very soft ground at the 140-foot level and is very economically and efficiently concentrated by means of hand jigs. Close to the Joplin-Columbus property a new mine was developed in 1914 by the Buckeye Mining Co. Two shafts were sunk and a 100-ton mill was built, which was first operated

in October, 1914, and made a good output of sphalerite practically free from lead or iron and averaging from 62 to 64 per cent zinc content.

The Joplin Royalty Mining Co. extracted ore by means of two 72-foot shafts located on the Kansas side of the State line, near the Klondike camp in Missouri. Although the shafts are in Kansas, the ore hoisted was obtained from drifts on the Missouri part of the mine. The concentrating plant of 250 tons was only operated about four months, but an extensive drilling campaign was undertaken. It is stated that "blanket ground" similar to that of the Diplomat mine at Galena was found at the depth of 100 feet. This "blanket ground" appears to lie at the same depth approximately as that at the Diplomat and to contain the same relatively high galena content.

As a full list of mines, descriptions and capacities of concentrating plants, and depth of workings of mines in the district were given in the 1913 report, such descriptions are omitted in this chapter. The producing lands and leases in the district in 1914 were as follows: Lockport Mining Co., Bonanza Lead & Zinc Co., Connor Investment Co., Clermont Land & Mining Co., Empire Mining Co., Glick Land & Mining Co., Galena Lead & Zinc Co., Hartford Mining Co., Promoter Mining Co., Illinois Lead & Zinc Co., Latawanna Mining Co., Luscombe & McElroy, Murphy Mining & Royalty Co., Playter Mining Co. of Kansas, James Murphy, Kennedy & Capps, L. K. Moeller, Ryan & Jarrett, Portia Mining Co., Fred L. Stone, Wyandotte Lead & Zinc Co., Joplin Royalty Mining Co., Joplin Columbus Mining Co., and Buckeye Mining Co. The chatting mills operated were those of C. W. Squires and J. C. Monlux.

KENTUCKY.

By J. P. Dunlop.

PRODUCTION.

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in Franklin, Mercer, Scott, Owen, or Henry counties, in the central districts, reported any lead or zinc concentrates shipped in 1914. The mines in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of the southern Illinois lead and zinc region. The earliest available records of the occurrence of fluorspar and the associated galena in the Kentucky-Illinois region appeared in the first, second, and third volumes of the American Journal of Science, published in 1818, 1820, and 1821.[1]

The presence of zinc blende was recognized in 1854–1857 during the first geological survey of the State of Kentucky by David Duke Owen and his assistant, Sidney S. Lyon. The first lead smelter using galena from Kentucky was erected by the River Valley Mining Co. at the Royal mine [2] about 1870.

Between 1874 and 1877 lead was shipped by Page & Krausse, who had erected a concentrating plant and a small Scotch-hearth smelter at the Columbia mine in Crittenden County. Mr. Fohs estimates the lead production of Kentucky previous to 1880 to have been at

[1] Ulrich, E. O., and Smith, W. S. T., The lead, zinc, and fluorspar deposits of western Kentucky: U. S. Geol. Survey Prof. Paper 36, pp. 16–17, 1905.

[2] Fohs, F. J., Fluorspar deposits of Kentucky: Kentucky Geol. Survey Bull. 9, 1907.

least 1,000 tons. No record of lead shipments between 1880 and 1900 is available.

Between 1900 and 1906 shipments of galena were reported to have been made from the Morning Star, Marble, and other mines. The lead output for the period of 1907 to 1914, inclusive, reported to the United States Geological Survey amounted to 349 tons, so that the total Kentucky production of lead to the end of 1914 probably exceeded 1,700 tons.

Considerable quantities of galena ores have been produced in former years, but at the present time lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content varying from a very small quantity to over 3 ounces a ton, but no recovery of this silver content has been reported by the smelters during the last three years. The lead concentrate shipped in any one year from Kentucky does not necessarily represent the actual recovery of lead from fluorspar mined in that year, for, being merely accessory to the fluorspar and produced in small quantities, it is frequently held until a considerable quantity has accumulated or until lead prices are high.

The following description of early zinc mining in Kentucky is taken from Bulletin 9 of the Kentucky Geological Survey:

Although zinc had been discovered as early as 1835 in western Kentucky, no deposits were worked to recover zinc till in May, 1901, when Blue & Nunn made their first shipments of zinc carbonate from the Old Jim mine. Thousands of tons, largely carbonate, some sulphide, were mined from an open cut, the mineral being gotten practically from the surface to a depth of 40 feet on either side of an igneous dike, the deposit in places exceeding 50 feet in width. The ore was hand cleaned, the pea ore product washed with log washer, and the sand ore cleaned on two Overstrom tables. The largest shipments of zinc ore from the district were made in 1902, the product being all from this mine.

Small shipments of sulphide were made by the Western Kentucky Mining Co. from the Lanham shaft of the Columbia mines in 1901. Its successor, The Columbia Mining Co., made no shipments in 1902, when it erected the Columbia mill for concentrating lead and zinc, from which it shipped several carloads of zinc both in 1903 and 1904.

The Mann zinc mine was discovered in 1901, and the Marion Zinc Co. made small shipments from both the Mann and McDowell mines, which adjoin, in 1902, and, although they have been operated some since, owing to litigation in connection with the Mann mine no further shipments have been made. The Old Dad mine was opened in 1903, and shipments of zinc carbonate were made from it in 1903 and 1904. This was in part hand cleaned and in part washed with log washers. The Henderson Co. also made small shipments in 1903 from its Lady Farmer mine, which adjoins the Old Jim, which received treatment similar to the latter, making shipments also in 1904. Blue & Nunn made some shipments in 1904 from the Nine Acre mine. Part of this ore was hand picked, part hand jigged, and part put through the Columbia mill. A number of deposits were somewhat exploited in these years, from which no shipments were made, owing to lack of milling facilities.

Only 403.8 short tons of zinc ore were shipped in 1905, of which 126 tons were sulphide and 277.8 tons were carbonate. These shipments showed a decrease of 555 tons from that of 1904. The decrease is attributable to the fact that the Old Jim mine was idle during the year, except for a little development work, this mine having previously supplied the bulk of carbonate and part of the sulphide ore.

The Old Dad mine was the largest zinc mine producer during 1905, but, because of a large amount of development work in progress, the production was small. The fact that some of the more important zinc mines were idle, or only a little development work was being done at them, also accounts for the decrease in tonnage.

Among those who made small shipments of zinc ore in 1905 were Blue & Nunn, Watkins & Drescher, the Henderson Co., and the Marion Mineral Co. A small amount was produced which was not put on the market.

In 1906, the zinc production was even less than in 1905. Although some new carbonate deposits were opened, little of such carbonate was shipped. (See finds at

Old Jim sinkholes and Lady Farmer, under "Progress in 1906.") The Old Dad was able to get out scarcely any ore owing to caving of the 60-foot open cut, which had to be recaught before further extraction of ore was feasible. The Old Jim mill was reerected at this mine and some nice concentrates from zinc dirt obtained. There was a small shipment from the Hodge open cut as well as from the Old Jim. In the matter of sulphides, the first shipments of zinc separated from fluorspar-zinc ores are to be recorded a distinct advance, auguring well for increased shipments in 1907. These were from the Sanders mill, discussed on a subsequent page. As a result, two companies have been organized to reopen the Columbia and Nine Acre mines, and a mill is to be erected equipped with Sanders separators at the latter. Other developments tending to increase the zinc production are to be looked for, and altogether the outlook is bright.

The total zinc-ore shipments from the district to date are:

	Short tons.
Zinc sulphide or sphalerite	1,164
Zinc carbonate or smithsonite	8,958
Total zinc ore	10,122

The production of sphalerite in Kentucky from 1907 to 1914, inclusive, reported to the United States Geological Survey, was 793 tons and that of zinc carbonate 2,737 tons, so that the total output of zinc ores from Kentucky has been 1,887 tons of sphalerite and 11,695 tons of zinc carbonate.

The production of lead, zinc, and silver in Kentucky in 1907–1914 is shown in the following table:

Production of lead and zinc in Kentucky, 1907–1914, in short tons.

Year.	Ores.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.							
			Sphalerite.		Zinc carbonate.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1914	26	$800	27	$1,120	644	$12,168	16	$1,248	230	$23,460
1913	40	1,422	198	5,206	696	13,811	22	1,936	327	36,624
1912	151	6,827	498	25,391	750	16,006	106	9,540	491	67,758
1911	.....	.....	.....	.....	467	10,604	.....	.....	158	18,012
1910	56	1,980	.....	.....	30	300	41	3,608	6	648
1909	12	620	.....	.....	150	1,701	10	860	64	6,912
1908	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1907	54	2,850	.....	.....	.....	.....	34	3,604	.....	.....

The quantity of sphalerite shipped decreased from 198 tons, valued at $5,206, in 1913 to 27 tons, valued at $1,120, in 1914, and that of zinc carbonate decreased from 696 tons, valued at $13,811, in 1913 to 644 tons, valued at $12,168, in 1914. The estimated recoverable spelter content in 1914 was 230 tons, valued at $23,460.

The shipments of galena concentrates reported in 1914 were 26 tons, valued at $800, compared with 40 tons, valued at $1,422, in 1913. The average lead content was 63 per cent, compared with 55 per cent in 1913. The recoverable metallic content of the galena in 1914 was 16 tons, valued at $1,248.

The Roberts Fluorspar Co. was the principal seller of galena concentrates. The Kentucky Fluorspar Co. recovered considerable galena from fluorspar mined or purchased, but made no sales in 1914.

The production of zinc concentrates was largely that of the Sanders Ore Separating Co. Some of this output was derived from tailings at the Commodore mine which were treated at its flotation plant, and

the remainder was smithsonite, containing 38 per cent zinc content, from the Miller mine. The American Spar Co. shipped a good output of zinc carbonate obtained by surface workings or shallow tunnels on the land of the Eagle Fluorspar Co.

MICHIGAN.

By B. S. Butler.

PRODUCTION.

In 1914 the mines of Michigan produced 164,344,058 pounds of copper, valued at $21,857,759, and 413,500 fine ounces of silver, valued at $228,665, a total value in copper and silver of $22,086,424. This is an increase of $850,861 in value over the production of 1913.

In 1914, as in 1913, the output from the district was considerably below normal, owing to unusual conditions. The miners' strike which was called July 23, 1913, continued till April 12, 1914, and affected the production for the early months of 1914. Conditions had not become normal when the breaking out of the European war early in August caused a depression which continued for the remainder of the year, though the output from Michigan mines was less affected by the war than that of many other districts, and early in 1915 there began to be a strong demand for Michigan copper.

For 1913 the average price of copper per pound was $0.155, and for 1914 it was $0.133. The average price of silver for 1913 was $0.604 per fine ounce, and for 1914 it was $0.553. Owing to the decrease in the price of copper there was a decrease from $3 in 1913 to $2.35 in 1914 in the average value per ton of rock treated.

The smelter production, or the output of refined copper, for 1914 was 158,009,748 pounds as compared with 155,715,286 pounds in 1913. The difference between the mine and the smelter production is due to the fact that the quantity of "mineral" produced is not the same as the quantity smelted. A company may produce either more or less "mineral" than it smelts during the year.

The following table shows the average values in copper and silver of "rock" treated in 1913 and 1914:

Value of silver and copper product of Michigan mines in 1913 and 1914.

Year.	Silver.	Copper.		Combined silver and copper, total value.
		Value.	Price per ton of rock.	
1913	$178,285	$21,057,278	$3.00	$21,235,563
1914	228,665	21,857,759	2.35	22,086,424
Increase (+) or decrease (−)	+50,380	+800,481	−.65	+850,861

The entire Michigan output of copper and silver is from the Keweenaw district. Both metals occur native in lodes remarkable for their great extent and uniformity. These lodes may be divided into two general classes—the amygdaloid, in which the metals occur together with gangue minerals, epidote, calcite, zeolites, etc., in the cellular portions of lava flows; and the conglomerate, in which the metals and gangue minerals cement and to some extent replace the pebbles forming the conglomerate. Native copper and copper minerals occur in

fissures in the district, but the present output from this type of deposit is of little importance. The "rock" [1] is of low grade and requires milling, which produces "mineral" carrying an average of about 65 per cent copper. A small quantity of "barrel" and "mass" copper is sorted at the mines and sent direct to the smelters.

In 1914 there were 9,269,413 short tons of "rock" milled, which yielded 264,140,504 pounds of "mineral" and 164,344,058 pounds of copper.[2]

The average recovery of refined copper per ton of "rock" milled in 1914 was 17.7 pounds, as compared with 19.4 pounds in 1913.

There were 413,500 ounces of silver derived from the electrolytic treatment of 37,430,000 pounds of copper. This electrolytic copper was recovered from approximately 2,000,000 tons of "rock," an average of 0.20 fine ounce of silver per ton of "rock."

The following table shows the production of metal, "mineral," and "rock" in Michigan for 1913 and 1914:

Production of silver, copper, "mineral," and "rock" in Michigan in 1913 and 1914.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1913	295,173	135,853,409	19.4	0.97	214,153,571	63.44	7,016,370
1914	413,500	164,344,058	17.7	0.89	264,140,504	62.22	9,269,413
Increase (+) or decrease (−)	+118,327	+28,490,649	−1.7	−0.08	+49,986,933	−1.22	+2,253,043

The following table shows the relative productive importance of the amygdaloid and the conglomerate rock in 1913 and 1914:

Production of "rock" and "mineral" and yield in silver and copper in Michigan in 1913 and 1914, by kinds of rock.

	1913		1914	
	Amygdaloid "rock."	Conglomerate "rock."	Amygdaloid "rock."	Conglomerate "rock."
Silver:				
Fine ounces	295,173		413,500	
Average yield per short ton of rock...ounce..	0.04		0.04	
Copper:				
Pounds	95,519,061	40,334,348	164,344,058	
Per cent of total	70.3	29.7	----------	
Average yield per short ton of rock..pounds..	16.8	30.1	17.7	
Average yield...per cent..	0.84	1.50	0.89	
"Mineral":				
Pounds	214,153,571		195,076,545	69,063,959
Per cent of total	----------		73.9	26.1
Average yield in copper...per cent..	63.4		62.2	
"Rock":				
Short tons	5,674,312	1,342,058	7,764,694	1,504,719
Per cent of total	81.0	19.0	83.8	16.2

[1] Some of the terms used to designate the different materials entering into the mining industry differ for the Lake district from those employed in any other part of the country. Ore is known as "rock" or "copper ground" (if unmined); the product of concentration is known as "mineral;" the term "ore" is used to designate the copper minerals (arsenides, sulphides, etc.) that occur to a limited extent in the district. Large bodies of native copper are known as "mass" and smaller ones are designated as "barrel work." In this report the local terms will be used, as it does not seem desirable to employ the more usual terms to the exclusion of the local, while a mixture of the two is confusing.

[2] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during 1914.

Three counties, Houghton, Keweenaw, and Ontonagon, contributed to the output of copper and silver in 1914. The following table shows the relative importance of these counties in output of copper and silver for 1913 and 1914:

Production of silver and copper in Michigan for 1913 and 1914, by counties.

1913.

County.	Silver.	Copper.		"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."	Quantity.	Yield.	
	Fine oz.	*Pounds.*	*Pounds.* *Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
Houghton	253,030	113,129,113	19.6 0.98	180,670,976	62.6	5,768,454
Keweenaw	42,143	19,090,109	19.4 .97	28,268,525	67.5	984,205
Ontonagon	.....	3,634,187	13.8 .69	5,214,070	69.7	263,711
Total	295,173	135,853,409	....	214,153,571	.....	7,016,370
Average	.....	.....	19.4 .97	.....	63.4	.....

1914.

Houghton	382,625	130,276,142	17.8 0.89	213,045,909	61.1	7,322,343
Keweenaw	30,875	30,785,464	19.3 .97	44,332,470	69.4	1,595,584
Ontonagon	.....	3,282,452	9.3 .47	6,762,125	48.5	351,486
Total	413,500	164,344,058	....	264,140,504	.....	9,269,413
Average	.....	.....	17.7 .89	.....	62.2	.....

REVIEW BY COUNTIES.[1]

In the following reviews of the operations at the individual mines of the district during 1914, the statements concerning the quantity, character, and tenor of "rock" developed, the quantity of rock stamped, the copper recovered per short ton of rock stamped, and the cost of production are based on the published reports of the companies. In the few cases in which reports are not published a general statement of the character of operations is made from the best information available.

The general strike of miners, which was called July 23, 1913, was not called off till April 12, 1914. Conditions of the copper market resulting from the European war resulted in a curtailment of production after August 1. Conditions were, therefore, abnormal for a greater part of the year, and the cost of producing copper either in 1913 or 1914 by individual companies or for the district as a whole can not be regarded as normal, as is readily seen by comparison with the costs in earlier years.

HOUGHTON COUNTY.

In 1914 the mines of Houghton County produced 130,276,142 pounds of copper and 382,625 ounces of silver. The county occupies the central portion of the copper belt and contains 13 of the 20 mines that contributed in 1914 to the copper output and 8 of the 10 mines that produced silver.

[1] Those desiring more details concerning individual properties are referred to a report by Reginald E. Hore, Mineral Resources of Michigan: Michigan Geol. and Biol. Survey, pp. 15–115, 1911. This report contains a description of the geology, ore deposits, methods of extraction, and treatment of ores, of developments at individual properties, of cost of production, etc., and gives references to the more important publications concerning the copper industry of the district.

The details of the production in 1913 and 1914 are shown in the following table:

Production of "rock" and "mineral" and average yield in silver and copper in Houghton County in 1913 and 1914.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1913	253,030	113,129,113	19.6	0.98	180,670,976	62.6	5,768,454
1914	382,625	130,276,142	17.8	.89	213,045,909	61.1	7,322,343

The output of the county shows an increase of 17,147,029 pounds of copper and of 129,595 fine ounces of silver for 1914.

Calumet & Hecla.—The Calumet & Hecla Mining Co. has been one of the most successful copper mining companies in the world. In yield of copper and in dividends paid it ranks first among the copper mines of the county. To the close of 1914 the company had distributed $124,250,000 in dividends.

The company's ground contains three copper-bearing lodes—the Calumet and Hecla conglomerate, the Osceola amygdaloid, and the "Kearsarge" amygdaloid. A large percentage of the production in the past has come from the conglomerate lode, but with the decrease in copper content of this lode and its approaching exhaustion, the mining from the amygdaloid lodes has increased.

The company's annual report shows the details of operation for 1914 as follows:

During 1914 there were 2,592,462 short tons of rock stamped, yielding 53,691,562 pounds of copper, or an average of 20.70 pounds of copper per ton of "rock." This compares with a yield of 22.11 pounds for 1913 and of 24.18 pounds for 1912. The total cost per pound of copper was 11.35 cents for 1914, as compared with 14.25 cents for 1913.

The conglomerate lode is opened for a distance of nearly 2 miles along its strike by 10 inclined shafts and 1 vertical shaft. The inclined shafts vary in depth on the dip of the lode from 6,102 to nearly 8,000 feet. The Red Jacket vertical shaft has a depth of 4,900 feet. The lode in the "Five Forties" tract, extending north from the company's main holdings, is developed by a slope shaft from the fifty-seventh level. The rock from this shaft is hoisted to the surface through the Red Jacket shaft.

In 1914 the conglomerate lode produced 1,439,986 tons of "rock," yielding 37,996,045 pounds of copper, or an average of 26.38 pounds per ton of "rock," as compared with 27.85 pounds for 1913 and 29.73 pounds for 1912.

The cost of producing copper from the conglomerate lode in 1914 was 10.42 cents per pound, as compared with 12.67 cents in 1913 and with 8.87 cents in 1912.

The Osceola lode is developed by six shafts, varying in depth from 1,460 to 3,274 feet. The lode has an average width of from 30 to 35 feet, though at some points it is much wider. The mineralization is confined principally to the hanging and the foot walls. The lode is

opened by drift stopes along the hanging wall, where the mineralization is rather uniform. Crosscuts are extended to the footwall, where the mineralization is far less regular. During 1914 this lode produced 1,152,476 tons of "rock," yielding 15,695,517 pounds of copper or 13.62 pounds per ton of "rock." This compares with a yield of 14.31 pounds for 1913 and of 15.08 pounds for 1912. The average cost per pound of copper from this lode for 1914 was 10.20 cents, as compared with 10.36 cents for 1912 and with 12.62 cents for 1913.

The Kearsarge lode is opened by three shafts, varying in depth from 1,350 to 2,291 feet. Development on this lode in Calumet & Hecla ground has not been encouraging, though the lode has proved very productive farther north. There was no output from the Kearsarge lode in 1914.

The recrushing plants treated 427,559 tons of coarse tailings containing an average of 11.58 pounds of copper per ton; 1,664,067 pounds of copper were recovered, or an average of 3.89 pounds per ton of tailings treated. The cost per pound of copper recovered, exclusive of smelting and selling, was 7.02 cents. The recovery from the No. 2 plant was 4.59 pounds per ton, as compared with 3.74 pounds for the No. 1 plant, and the cost of copper 5.66 cents per pound, as compared with 7.38 cents for the No. 1 plant.

The electrolytic plant at Hubbell was put in commission during the year, and the Black Rock plant at Buffalo, N. Y., was discontinued. A part of the No. 2 regrinding plant was placed in commission during the year, and work was started on a leaching plant. Installation of the machinery in the dredge to remove tailings from Torch Lake was completed.

Tamarack.—The Tamarack ground lies northwest of the Calumet & Hecla, and its operations are conducted on the underlays of the Calumet & Hecla conglomerate and the Osceola amygdaloid. Both lodes enter the property at considerable depth and are reached by vertical shafts, the different levels being connected with these shafts by crosscuts. The property is opened by five shafts, varying in depth from 3,409 feet (No. 1) to 5,308.5 feet (No. 5).

The company, although at a disadvantage on account of the great depth of the mine and the consequent high mining costs, has made a good record in dividends, which from 1888 to 1907 aggregated $9,420,000. Since the decline in the price of copper in 1907, however, the company has been unable to show a profit until 1912, when relatively high prices again prevailed and copper was produced at a profit.

The average cost per pound of production during the last four years has been 15.56 cents for 1911, 13.15 cents for 1912, 16.60 cents for 1913, and 29.08 cents for 1914.

The mine was closed till May on account of the labor strike and was again closed in August, owing to the unfavorable conditions resulting from the European war. Developments and production for the year were, therefore, relatively slight.

During the year 57,410 tons of "rock" were stamped, yielding 1,743,145 pounds of "mineral" and 1,074,808 pounds of copper, or 18.7 pounds of refined copper per ton of "rock" stamped. This compares with a yield of 19.1 pounds in 1911, 18.8 pounds in 1912, and 18.3 pounds in 1913.

During the year a crushing plant was in process of construction, which, when completed, will consist of 32 Hardinge conical pebble mills and 92 Wilfley tables.

Osceola.—During 1914 the Osceola Co. operated the three branches—the Osceola, the South Kearsarge, and the North Kearsarge. Since 1878 this company has distributed dividends to the amount of $12,179,675.

The Osceola branch lies directly south of the Calumet & Hecla, and is worked on the Osceola amygdaloid. The property contains the Calumet & Hecla conglomerate lode, but the only portion of this in Osceola ground that has been shown to carry copper in paying quantities was worked out in the early days of the mine.

A total of 261,436 tons of "rock" was produced, yielding 2,972,000 pounds of copper, or an average of 11.37 pounds per ton, at a cost of 15.07 cents per pound.

Tests of the rock from No. 5 shaft in June and July, 1914, showed it to be lean and a number of stopes were abandoned. Under the unfavorable conditions in August, underground work at this shaft was discontinued. The south workings of No. 6 shaft showed a gradual improvement in the grade of "rock" during the year. Repairs were made to No. 3 shaft with a view to opening it to mine the foot-wall rock near the shaft which contains copper.

The North Kearsarge lies north of the Wolverine, and is worked on the Kearsarge lode. No. 1 shaft has a depth of 3,873 feet, No. 3 shaft has a depth of 3,403 feet, and No. 4 shaft has a depth of 1,449 feet. A total of 1,808 feet of opening was accomplished on this branch during the year. This branch produced 458,609 tons of rock, yielding 5,695,737 pounds of copper, or an average of 12.42 pounds per ton, at a cost of 11.62 cents per pound.

The South Kearsarge lies south of the Wolverine and east of the Centennial on the Kearsarge lode. No. 1 shaft has a depth of 2,820 feet, and No. 2 shaft has a depth of 1,992 feet. Only a small amount of new openings were made at this division during 1914.

This branch produced 388,402 tons of rock, yielding 6,303,000 pounds of copper, or an average of 16.23 pounds per ton, at a cost of 7.92 cents per pound.

In 1914 the company treated 1,108,447 tons of rock, producing 20,997,900 pounds of "mineral," and 14,970,737 pounds of copper, an average yield of 13.5 pounds of refined copper per ton of rock. This compares with a yield of 14.8 pounds in 1911 and 1912, and 15.4 pounds in 1913. The total cost of refined copper per pound was 10.79 cents for 1914, as compared with 12.30 cents in 1913.

Centennial.—The Centennial ground lies north of the Calumet & Hecla and west of the South Kearsarge and the Wolverine. It contains the Calumet & Hecla, the Osceola, and the Kearsarge lodes, the last being the only one of proved value in the property, and to this lode operations are at present confined.

At the close of 1914 the depth of No. 1 shaft was 3,821 feet. No work was done in the vicinity of this shaft during 1914. Shaft No. 2 has a depth of 4,293 feet at the close of the year. A total of 2,278 feet of development was accomplished at this shaft. The openings to the north showed average ground for the first nine months of the year, but were lean for the latter part of the year except on the thirty-fourth level.

"Rock" to the amount of 138,136 tons was stamped during the year, producing 3,311,780 pounds of "mineral" and 2,287,130 pounds of refined copper, or 16.56 pounds refined copper per ton of rock stamped. The average cost of refined copper per pound was 12.56 cents, as compared with 13.38 cents for 1913.

Wolverine.—The Wolverine is located between the North and the South Kearsarge branches of the Osceola Co. Its operations are on the "Kearsarge" amygdaloid, though the West lode, parallel with the Kearsarge lode and about 80 feet to the west, has been opened to a small extent. The mine has the distinction of having the richest amygdaloid and, next to the Calumet and Neecla conglomerate, the richest rock mined in the district. The Kearsarge lode is opened by five shafts, numbered from 1 to 5, from north to south. No. 1 is abandoned; No. 2, bottomed at the boundary at a depth of 1,700 feet, is used for handling men and supplies; No. 3 has attained a depth of 4,005 feet and can be sunk to a depth of 4,300 feet before reaching the boundary; No. 4 has a depth of 3,872 feet; No. 5 was sunk to a depth of 631 feet on the Osceola lode prior to June, 1913. The operations on the Osceola lode have thus far proved disappointing. The Kearsarge lode in the Wolverine ground shows great uniformity of mineralization, and is opened for the full length. In the upper levels the rock averaged from 16 to 18 pounds per ton, but as the lower levels were opened it showed marked improvement, the average for the fiscal year ending June 30, 1914, being 18.86 pounds per ton.

During the fiscal year ending June 30, 1914, 182,127 tons of "rock" were stamped, producing 4,606,015 pounds of "mineral," yielding 3,435,459 pounds of copper, or 18.86 pounds of refined copper per ton of "rock" stamped. The total cost per pound of refined copper was 11.72 cents.

Since organization to June 30, 1914, the company has produced 137,410,752 pounds of copper. Operations have resulted in profits amounting to $8,569,109.29, of which $7,740,000 has been paid in dividends.

Franklin.—The Franklin and the Rhode Island, which is controlled by the Franklin, are located southeast of the La Salle. The property carries several lodes, but in the past exploration has been principally on the "Pewabic" amygdaloid and the Allouez or "Albany and Boston" conglomerate.

The exploratory crosscut on the thirty-second level reached the Allouez conglomerate early in 1914.

Exploration on the conglomerate revealed promising "rock."

Mill tests on this "rock" showed recoveries from 10.46 to 16.89 pounds per ton, with an average of 12.73 pounds per ton, the tailings averaging 6 pounds per ton. A crosscut was driven to the Allouez conglomerate on the thirty-seventh level, where an encouraging grade of rock was encountered. An extension of the thirty-second level crosscut beyond the Allouez conglomerate encountered several amygdaloids, one of which carried copper in quantities warranting further development.

Production was confined to mill tests. An output of 7,324 tons of "rock" yielded 175,944 pounds of "mineral" containing 93,288 pounds of copper, or 12.73 pounds of copper per ton of "rock."

Quincy.—The Quincy mine is situated just north of the east-west arm of Portage Lake. The property is traversed by most of the

lodes of the district, but has derived its principal output in the past from the Pewabic lode, with a small quantity from the West lode.

The ground developed was of the same general character as that of the previous year.

Dividends during 1914 to the amount of $55,000 have been paid. The total disbursement of dividends from 1862 to 1914 has been $20,897,500.

In March serious damage to shafts No. 6 and No. 2 was done by "air blasts," and this, together with strike conditions and war conditions during the year, seriously interfered with normal operations.

In 1914 there were mined and sent to the stamp mill 1,016,660 tons of "rock," which yielded 22,612,460 pounds of "mineral" and 15,356,380 pounds of copper.

Isle Royale.—The Isle Royale mine is situated south of the east-west arm of Portage Lake, near Houghton. The property contains several copper-bearing lodes, of which the Isle Royale is the main producer at present.

A total of 9,694 feet of openings was accomplished during 1914.

The stamp mill was destroyed by fire on December 24. Steps were immediately taken for its reconstruction, and it is hoped to have the new mill in operation in June, 1915.

During 1914 "rock" amounting to 474,349 tons was treated, yielding 9,451,115 pounds of "mineral" and 6,601,235 pounds of copper, or an average of 13.9 pounds of copper per ton. The average cost per pound of copper was 13.05 cents as compared with 18.81 cents in 1913.

Baltic, Champion, and Trimountain.—These three mines are located on the Baltic lode southwest of Houghton and are under the same management, that of the Copper Range Consolidated Co. The Baltic is an exceptionally strong lode, having a stoping width varying from 15 to 80 feet. The lode has produced considerable "mass" copper and also contains veinlets of copper minerals, including chalcocite, bornite, and copper arsenides. These minerals are recovered in the mill, and the arsenides probably account in part for the arsenical character of the Copper Range output.

During 1914 the Baltic operated 3 shafts with depths of 2,469 feet for No. 2, 2,766 feet for No. 3, and 2,554 feet for No. 4.

A total of 324,433 tons of "rock" was stamped, producing 7,001,945 pounds of refined copper, or 21.58 pounds of refined copper per ton of "rock" stamped. The cost per pound of refined copper was 11.17 cents.

Since organization and to the close of 1914 the Baltic company has produced 176,129,415 pounds of copper at a profit of $8,440,550.85, of which $7,950,000 has been distributed as dividends.

The Trimountain is also opened by 3 shafts, with depths of 2,859 feet for No. 2, 2,461 feet for No. 3, and 2,431 feet for No. 4. at the close of 1914. Openings made during the year showed average values.

A total of 227,251 tons of "rock" was stamped, yielding 5,048,306 pounds of refined copper, or an average of 18.21 pounds per ton. The average cost per pound of copper was 12.21 cents.

Since organization the company has produced 93,506,574 pounds of copper at a profit of $1,953,397.61, of which $1,450,000 has been disbursed as dividends.

The Champion, controlled jointly by the Copper Range Consolidated Co. and the St. Mary's Mineral Land Co., is opened by 4 shafts with depths varying from 2,239 to 2,514 feet, at the close of 1914. The openings made during the year were in good ground.

A total of 614,854 tons of "rock" was stamped, yielding 15,807,206 pounds of refined copper, a yield of 25.71 pounds per ton of "rock" stamped. The cost of refined copper per pound was 9.8 cents.

From its organization to the close of 1914 the Champion company has produced 191,864,475 pounds of copper at a profit of $9,606,819.44, of which $8,400,000 has been disbursed as dividends.

Superior.—The Superior is located northeast of the Baltic on the Baltic lode. The lode on this property is being opened by two shafts. At the close of 1914 No. 1 shaft had reached a depth of 2,188 feet and No. 2 a depth of 1,628 feet.

During the year 191,628 tons of "rock" were stamped, producing 3,217,635 pounds of copper, or 16.79 pounds per ton of "rock" stamped. The cost of copper a pound was 12.42 cents.

La Salle.—The La Salle company produced 45,509 tons of "rock," yielding 540,731 pounds of copper, or an average of 11.88 pounds per ton of "rock."

Winona.—The Winona produced 123,339 tons of "rock," which yielded 2,239,170 pounds of "mineral" and 1,352,085 pounds of refined copper, an average of 10.96 pounds of refined copper per ton of "rock" stamped.

Other companies.—Other companies were active in development work, but for the most part the operations of nonproducing companies were greatly curtailed or suspended on account of the unfavorable conditions that prevailed in the district during a large part of the year.

KEWEENAW COUNTY.

In 1914 Keweenaw County produced 30,785,464 pounds of copper and 30,875 fine ounces of silver. The county occupies the northern portion of the copper belt. This section of the belt produced considerable copper in the early days of Lake mining, but of late years it has furnished a comparatively small percentage of the total output. Developments, however, indicate that the county should increase in importance in the future.

The following table shows the production of "rock" and "mineral" and the average yield in silver and copper in Keweenaw County in 1913 and 1914:

Production of "rock" and "mineral" and average yield in silver and copper in Keweenaw County in 1913 and 1914.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1913	42,143	19,090,109	19.4	0.97	28,268,525	67.5	984,205
1914	30,875	30,785,464	19.3	.97	44,332,470	69.4	1,595,584

Ahmeek.—The Ahmeek mine, lying north and east of the Allouez, is located on the Kearsarge lode. The lode is opened by four shafts.

No. 1 has a depth of 2,506 feet; No. 2, a depth of 2,693 feet; No. 3, 2,144 feet; and No. 4, 2,158 feet. Openings during the year at all the shafts showed ground of average value.

During the year construction of the addition to the mill was in progress. A total of 590,519 tons of "rock" was stamped, yielding 20,333,000 pounds of "mineral" and 13,634,605 pounds of refined copper, or 23.1 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 9.71 cents.

Allouez.—The Allouez mine is north of the North Kearsarge, and, as in recent years, operations were confined to the Kearsarge lode. As this lode does not outcrop on Allouez property, the shafts were started in the hanging wall at a steep angle and flattened to the dip of the copper-bearing bed just before reaching it. This plan avoids the expense of long crosscuts necessitated by vertical shafts.

A total of 354,457 tons of "rock" was stamped during 1914, yielding 9,408,470 pounds of "mineral," or 6,056,548 pounds of refined copper, an average of 17.09 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 11.18 cents.

Mohawk.—The Mohawk mine, lying east of the Ahmeek, carries the outcrop of the Kearsarge lode for more than a mile, and also contains several cross fissures carrying arsenides of copper, which have been mined to a considerable extent in the past. Operations were conducted through six shafts.

A total of 649,649 tons of "rock" was stamped, yielding 14,591,000 pounds of "mineral" and 11,094,859 pounds of copper, or an average of 17.08 pounds per ton of "rock." The total cost per pound of refined copper was 8.58 cents.

Since organization the Mohawk company has produced 117,423,967 pounds of copper, at a profit of $4,127,208.98, of which amount $3,275,000 has been disbursed as dividends.

ONTONAGON COUNTY.

In 1914 Ontonagon County produced 3,282,452 pounds of copper. Ontonagon County contains the southwestern portion of the copper belt. This portion has not been so thoroughly developed as the others, and consequently the geology is less understood than in the more northern counties. So far as developed, the lodes are more "bunchy" than to the north and have produced a relatively high percentage of mass copper. The production of 1914 was derived wholly from amygdaloid rock.

The following table shows the production of the county in 1913 and 1914:

Production of "rock" and "mineral" and average yield in silver and copper in Ontonagon County in 1913 and 1914.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1913		3,634,187	13.8	0.69	5,214,070	69.7	263,711
1914		3,282,452	9.3	.47	6,762,125	48.5	351,486

Mass.—The Mass mine, adjoining the Adventure on the southwest, carries six known copper-bearing amygdaloid lodes—the Knowlton, the Mass, the North Butler, the Butler, the Ogima, and the Evergreen. In addition, the position of the property makes it probable that the newly discovered lodes in this part of the district may be present in the Mass ground. The main developments for the year were from "B" and "C" shafts on the Butler and Evergreen lodes, and continued to show as satisfactory conditions with respect to copper values as in previous years.

A total of 78,250 tons of "rock" was stamped in 1913, yielding 1,773,810 pounds of "mineral" and 1,213,545 pounds of refined copper, an average of 15.51 pounds of refined copper per ton of "rock" stamped.

Victoria.—The Victoria is the most southwesterly of the Lake mines that have made important production. The first attempts at copper mining in the district are said to have been made at this locality, though its recent period of productiveness began in 1906. The present production is from the Forest lode.

A total of 5,471 feet of opening was accomplished in the mine during 1914, mainly from No. 2 shaft. "Rock" amounting to 124,842 tons was stamped, yielding 2,272,430 pounds of "mineral" and 1,486,242 pounds of refined copper.

Development by the White Pines Copper Co. was continued in 1914, and a mill was under construction and is expected to be placed in commission during 1915.

In this, as in other sections of the district, exploration and development by nonproducing companies were greatly restricted during 1914.

MISSOURI.

By J. P. Dunlop.

PRODUCTION

VALUE.

The value of the mine production of silver, copper, lead, and zinc in Missouri in 1914 was $25,874,864, compared with $29,604,890 in 1913. The value of the copper production showed a decrease of $82,398, that of silver an increase of $12,312, and the value of the lead decreased only $474,472, so that the large decrease in the value was caused mainly by the much smaller output and the lower average price of spelter in 1914 compared with 1913. The recoverable lead content of Missouri lead concentrates sold in 1914 was equal to 35.5 per cent of the smelter production of primary lead in the United States derived from domestic ores, and the recoverable spelter content from Missouri zinc concentrates sold in 1914 was 30.9 per cent of the primary spelter produced by smelters from domestic ores in 1914.

SILVER AND COPPER.

The following table shows the production of silver and copper in Missouri in the years 1910 to 1914, inclusive:

Mine production of silver and copper in Missouri, 1910–1914.

Year.	Copper.		Silver.		Lead concentrates, silver-bearing.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Fine ozs.*		*Short tons.*
1910	94,452	$11,955	33,096	$17,872	35,002
1911	640,411	80,051	49,867	26,430	51,109
1912	440,725	72,719	35,438	21,794	31,183
1913	576,204	89,312	35,620	21,514	35,854
1914	44,463	5,914	61,168	33,826	61,995

Silver.—For several years prior to 1914 the entire silver production has been derived from refining lead concentrates, but in 1913 a small quantity of silver was obtained from oxidized copper ore shipped by the Cornwall mine of Ste. Genevieve County and in 1914 some ore of the same character was shipped from the Swansea mine.

The quantities given in the fourth column of the foregoing table are those of recovered silver. The silver content of the lead ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied upon for the silver production. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of lead concentrates smelted during that year. The reason for this is that the silver content is so small in quantity that the silver bullion is stored and refined in batches. If a series of years be taken into account, the concentrates are seen to average about 1 ounce of silver to the ton.

Copper.—The production of copper in Missouri in 1914 was 44,463 pounds, valued at $5,914, as compared with 576,204 pounds, valued at $89,312, in 1913. The mines of the North American Lead Co., which produced some copper as well as nickel and cobalt in the years 1908 and 1909, were idle during 1914. The copper output for 1910, 1911, and 1912 was derived from concentrates recovered in dressing lead ore mined in St. Francois County, in southeastern Missouri. In 1913 there was an increased yield of copper from lead concentrates, but in 1914 the quantity of copper derived from this source was small. In 1913 a considerable quantity of copper was recovered from copper ore shipped by the Cornwall Copper Mining & Smelting Co., and in 1914 the Swansea mine in Ste. Genevieve County shipped some copper ore.

LEAD AND ZINC.

The production of lead and zinc in Missouri in 1914 is shown in the following table:

Production of lead and zinc in Missouri in 1914, by districts, in short tons.

District.	Ore.							
	Lead concentrates.				Zinc concentrates.			
	Galena.		Carbonate.		Sphalerite.		Silicate and carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Southwestern Missouri:								
Alba-Neck City	469	$20,444	.....	.....	24,738	$1,042,303	614	$12,180
Ash Grove-Everton	12	600	.....	.....	.....	.....	120	1,440
Aurora	62	2,357	1	$25	246	6,290	2,154	46,252
Carl Junction	53	2,408	.....	.....	3,847	146,792	.....	.....
Carthage	20	957	.....	.....	1,889	76,139	65	1,364
Cave Springs	105	4,640	.....	.....	2,652	112,602	.....	.....
Duenweg-Porto Rico	3,176	145,574	30	878	19,526	760,790	169	3,058
Granby	359	16,470	29	767	4,812	197,042	10,398	246,280
Joplin	4,407	201,573	93	2,089	36,437	1,403,476	2,080	42,063
Oronogo	1,670	78,988	.....	.....	9,472	391,334	.....	.....
Sarcoxie-Reeds	.....	.....	.....	.....	941	39,465	185	4,000
Sherwood-Thoms Station	846	39,217	.....	.....	9,536	327,000	18	154
Spring City-Beef Branch	1,416	63,916	42	959	3,581	120,973	1,397	24,585
Springfield	256	12,325	.....	.....	1,898	85,117	.....	.....
Spurgeon	144	6,306	.....	.....	1,223	43,499	7	148
Webb City-Carterville-Prosperity	17,396	827,926	.....	.....	64,089	2,414,476	.....	.....
Wentworth and Stott City	.....	.....	.....	.....	917	36,680	100	2,300
Zincite and Klondike	103	4,560	.....	.....	3,921	147,048	.....	.....
Christian and Ozark counties	.....	.....	.....	.....	.....	.....	1,844	20,079
	30,494	1,428,261	195	4,718	189,725	7,351,026	19,151	403,903
Central and southeastern Missouri	249,165	9,710,125	.....	.....	40	700	497	11,282
State total:								
1914	279,659	11,138,386	195	4,718	189,765	7,351,726	19,648	415,185
1913	255,400	11,434,387	323	10,548	225,850	9,180,900	21,531	483,463
1912	256,477	11,935,535	361	12,823	244,986	12,346,922	22,172	641,881
1911	258,906	12,460,902	234	8,358	217,812	8,680,559	20,119	477,420
1910	247,861	11,286,750	197	6,385	232,341	9,342,139	23,806	561,803
1909	249,151	10,893,024	385	11,124	229,023	9,445,826	28,525	677,213
1908	218,213	8,629,039	664	18,220	198,340	6,800,359	20,601	451,607
1907	193,528	10,535,890	357	11,764	222,347	9,208,465	18,733	427,146

Production of lead and zinc in 1914, by districts, in short tons.

District.	Metal content.[a]			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Southwestern Missouri:				
Alba-Neck City	366	$28,548	13,512	$1,378,224
Ash Grove-Everton	9	702	34	3,468
Aurora	47	3,666	875	89,250
Carl Junction	42	3,276	2,032	207,264
Carthage	16	1,248	1,040	106,080
Cave Springs	84	6,552	1,426	145,452
Duenweg-Porto Rico	2,503	195,234	10,216	1,042,032
Granby	286	22,308	6,170	629,340
Joplin	3,493	272,454	20,022	2,042,244
Oronogo	1,318	102,804	5,134	523,668
Sarcoxie-Reeds	.....	.....	577	58,854
Sherwood-Thoms Station	664	51,792	4,588	467,976
Spring City-Beef Branch	1,118	87,204	2,167	221,034
Springfield	211	16,458	1,073	109,446
Spurgeon	114	8,892	636	64,872
Webb City-Carterville-Prosperity	13,829	1,078,662	33,305	3,397,110
Wentworth and Stott City	.....	.....	532	54,264
Zincite and Klondike	73	5,694	2,002	204,204
Christian and Ozark counties	.....	.....	468	47,736
	24,173	1,885,494	105,809	10,792,518
Central and southeastern Missouri	168,439	13,138,242	185	18,870
State total:				
1914	192,612	15,023,736	105,994	10,811,388
1913	176,116	15,498,208	124,963	13,995,856
1912	177,069	15,936,210	136,551	18,844,038
1911	178,868	16,098,120	122,515	13,966,710
1910	161,016	14,169,408	129,589	13,995,612
1909	159,435	13,711,410	130,162	14,057,496
1908	144,459	12,134,556	107,404	10,095,976
1907	138,675	14,699,550	116,752	13,776,736

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the metal is calculated from the average daily quotations at New York and St. Louis.

The total value of the recoverable metallic content of the lead and zinc concentrates produced in Missouri in 1914 was $25,835,124, a decrease of $3,658,940 from that of 1913. The production of lead concentrates in Missouri in 1914 (of which all but 195 tons was galena) was 279,854 short tons, valued at $11,143,104, as compared with an output of 255,723 tons, valued at $11,444,935, in 1913, an increase of 24,131 tons in quantity and a decrease of $301,831 in value. Of this production in 1914 of lead concentrates 249,165 tons, valued at $9,710,125, was derived from southeastern and central Missouri, an increase of 29,654 tons in quantity and of $129,232 in value. The average metal content of the lead concentrates from these districts was 67.6, as compared with 67.2 in 1913, and the value per ton in 1914 was $38.96, a decrease of $4.67. The quantity of recoverable lead in southeastern and central Missouri concentrates in 1914 amounted to 168,439 tons, an increase of 20,881 tons. The output was equal to more than 31 per cent of the primary lead smelted or refined from domestic ores in the United States in 1914.

Shipments of lead concentrates from southwestern Missouri were 30,689 tons, valued at $1,432,979, as compared with 36,302 tons, valued at $1,864,042, in 1913. The lead carbonate concentrates amounted to only 195 tons, valued at $4,718, a decrease of 128 tons.

The quantity of recoverable lead from southwestern Missouri, or the Joplin region, was 24,173 tons, valued at $1,885,494, a decrease of 4,385 tons. The average metal content of the galena concentrates from southwestern Missouri was 78.9 per cent, and the average price per ton was $46.84, or $4.66 less per ton than in 1913.

The quantity of zinc blende concentrates sold from Missouri mines in 1914 was 189,765 tons, valued at $7,351,726, a decrease of 36,085 tons in quantity and of $1,829,234 in value, when compared with the 1913 figures. All of the blende concentrates except 40 tons was produced in southwestern Missouri. The average price received per ton was $38.74 and the average recoverable zinc content was 58.1 per cent. The average price paid per ton in 1913 was $40.70 and the average recoverable zinc content was 57.8 per cent. A smaller quantity of low-grade concentrates was shipped from certain districts than in 1913. The zinc content of the sphalerite concentrates derived from "sheet-ground" mines, which was 58.6 per cent in the years 1911 and 1912, declined to 58.3 per cent in 1913 and increased to 58.4 per cent in 1914. The average price received for sphalerite concentrates in 1914 was nearly $2 a ton less than in 1913.

The zinc carbonate and silicate concentrates sold in 1914 amounted to 19,648 tons, valued at $415,185. This was 1,883 tons less in quantity and $68,278 less in value than the sales in 1913. The output in 1914 was mainly from southwestern Missouri, the shipments from southeastern Missouri being only 497 tons, valued at $11,282, as compared with 639 tons, valued at $13,491, in 1913. The average metal content of the zinc carbonate and silicate concentrates was 38 per cent in 1914. The average value per ton in 1914 was $21.13 as compared with $22.45 in 1913.

The combined value of lead and zinc concentrates from southeastern and central Missouri in 1914 (which produced about 89 per cent of the lead concentrates) was $9,722,107, or $127,149 more than in 1913.

The total value of the southwestern Missouri lead and zinc concentrates was $9,187,908 as compared with $11,514,400 in 1913, a decrease of $2,326,492.

The total quantity of crude ore or "dirt" mined and treated in 1914 amounted to 11,492,300 short tons, a decrease of about 808,000 tons, or approximately 6.5 per cent less than the quantity mined and treated in 1913. As the total amount received for all classes of lead and zinc concentrates sold in 1913 was $18,910,015, the average value per ton of crude ore or "dirt" mined and treated was $1.65, compared with $1.72 in 1913 and $1.86 in 1912.

The small quantity of copper ore mined and shipped in 1914 is excluded from these calculations.

In the following tables showing the tenor of crude ore ("dirt") and concentrates from Missouri it has been considered advisable to segregate the ores of different nature. For instance, the disseminated lead ore of southeastern Missouri differs radically from the lead and zinc ores of the so-called "soft-ground" deposits of southwestern Missouri, and these in turn differ from the "sheet ground" deposits of the same region. Each class of ore has its peculiar problems of mining and ore dressing. This fact makes desirable the separate treatment of the statistical data. In general, the tables reflect very closely the conditions of the industry.

Tenor of crude lead and zinc ore and concentrates produced in southwestern Missouri in 1913 and 1914.[a]

	1913	1914
SOFT GROUND.[a]		
Total crude ore.....short tons..	3,745,400	3,179,830
Total concentrates in crude ore.....per cent..	4.56	4.61
Lead.....do....	.44	.48
Zinc.....do....	4.12	4.13
Metal content of crude ore.....do....	2.58	2.64
Lead.....do....	.34	.38
Zinc.....do....	2.24	2.26
Average lead content of galena concentrates.....do....	78.6	78.6
Average lead content of lead carbonate concentrates.....do....	62.2	51.3
Average zinc content of sphalerite concentrates.....do....	57.5	57.9
Average zinc content of silicates and carbonates.....do....	38.8	38.6
Average value per ton:		
Galena concentrates.....	$51.51	$46.16
Lead carbonate concentrates.....	$32.66	$24.19
Sphalerite concentrates.....	$39.93	$38.65
Zinc silicates and carbonates.....	$22.45	$21.13
SHEET GROUND.		
Total crude ore.....short tons..	4,303,900	3,594,170
Total concentrates in crude ore.....per cent..	2.63	2.69
Lead.....do....	.47	.44
Zinc.....do....	2.16	2.23
Metal content of crude ore.....do....	1.63	1.65
Lead.....do....	.37	.35
Zinc.....do....	1.26	1.30
Average lead content of galena concentrates.....do....	79.0	79.3
Average zinc content of sphalerite concentrates.....do....	58.3	58.4
Average value per ton:		
Galena concentrates.....	$51.43	$47.38
Sphalerite concentrates.....	$41.69	$38.86

[a] Including also the small production of lead and zinc ores in central Missouri.

Tenor of crude lead ore and concentrates in southeastern Missouri disseminated lead ore in 1913 and 1914.

	1913	1914
Total crude lead ore.....short tons..	4,250,800	4,718,300
Galena concentrates in crude ore.....per cent..	5.15	5.27
Lead content in crude ore.....do....	3.45	3.56
Average lead content of galena concentrates.....do....	67.2	67.6
Average value per ton of galena concentrates.....	$43.63	$38.96

SOUTHWESTERN MISSOURI.

AREA, ORES, DEPOSITS.

The southwestern Missouri lead and zinc area includes the largest part of the Joplin region, the remaining portion lying in southeastern Kansas and in northeastern Oklahoma. The Missouri part of the region was first developed, then that in Kansas, followed at a considerably later period by mining in Oklahoma. Although lead had been known to exist in southwestern Missouri early in the nineteenth century, it is reported that the mining of lead was begun in 1848 by William Tingle in Jasper County, 2 miles east of Joplin. In 1849 lead was discovered by Daniel Campbell within the limits of Joplin.[1] About 1851 mining was begun on Center Creek in the camp now known as Oronogo, and the Turkey Creek mines, a little northeast of Joplin,

[1] Winslow, Arthur, Lead and zinc deposits of Missouri: Missouri Geol. Survey, vol. 6, 1894.

were opened in 1854. In Newton County the first mining was in 1850, at Prairie Diggings, south of Granby, and on Shoal Creek, 5 miles northwest of Neosho. In 1857 mining was in full swing, and it is estimated that about 300 shafts were put down in and around Granby during the period from 1851 to 1860. Lead furnaces were erected at Granby and at other places in Newton and Jasper counties, which utilized the galena and some lead carbonate, but the zinc ore, having no value at that time, was thrown aside.

The Civil War checked development, but work was resumed at the Granby and other southwestern mines in 1865 and the construction of the St. Louis & San Francisco Railroad, which was finished as far as Springfield, had the effect of stimulating the mining and smelting industry. It was more than 20 years after the first discovery of lead near Joplin that the territory in and around the city became the scene of much activity. About 1870 many discoveries of lead and zinc ores were made near Joplin, Webb City, and Carterville, and in the succeeding four years the mining population increased very rapidly. Zinc ore was first reported shipped from Joplin about 1872. Some zinc ores were also shipped from Dade, Barry, and Greene counties and from Granby about 1873. By 1880 the Missouri production of lead ores had increased to 28,319 tons and that of zinc ores to 34,344 tons, and of these quantities about 17,000 tons of lead ore and 32,100 tons of zinc ore were derived from the southwestern districts. These figures show the great strides made in zinc output and their increasing predominance over the lead ores in the Joplin region. The succeeding years have shown a nearly constant expansion of the producing territory, cheaper operating methods, and the mining of ore bodies at increasing depths. New camps at Wentworth, Sarcoxie, Alba, Neck City, and Thoms Station have been discovered. The mine output of galena and of zinc carbonate and silicate from shallow workings declined, while that of sphalerite increased. After the opening of the "sheet-ground" territory near Webb City, that camp assumed the leading position in production.

In 1900 the Joplin camp was the largest producer of both lead and zinc concentrates in southwestern Missouri. According to figures given by Frank Eberle, of Joplin, the total output of the region for that year, exclusive of the Kansas production, was 199,203 tons of zinc concentrates and 24,118 tons of lead concentrates, as against an output of 34,344 tons of zinc concentrates and 28,319 tons of lead concentrates in 1880. In 1900 the output from Joplin camp was over 3,000 tons of zinc greater than that from the Webb City-Carterville camp, whereas in 1914 as well as in the several preceding years the Webb City-Carterville district has been the largest producer of both lead and zinc ores in the Joplin region.

It is difficult to segregate the production of southwestern Missouri from the total output of the Joplin region. The separation can be made for the Miami and Quapaw districts in Oklahoma and separate data are given by the United States Geological Survey for all districts since 1906. L. L. Wittich, in the Joplin News Herald (1915) statistics, gives the output of the Joplin region (including Kansas and Oklahoma) from 1850 to 1914 as 1,216,546 tons of lead concentrates and 6,431,018 tons of zinc concentrates, having an estimated total value of more than $267,000,000.

The total production and value of lead and zinc concentrates from the Missouri part of the Joplin region, as reported to the United States Geological Survey for the years 1907 to 1914, inclusive, are as follows:

Production of lead and zinc concentrates in Joplin (Mo.) region, 1907–1914.

Lead concentrates, 293,209 tons, valued at	$15,963,461
Sphalerite concentrates, 1,760,055 tons, valued at	72,344,912
Zinc carbonate and silicate concentrates, 168,781 tons, valued at	3,997,249
Total value	92,305,622

The average price per ton received for sphalerite concentrates during the period 1907 to 1914 was $41.10 and that for zinc silicate and carbonate was $23.68.

The ore in southwestern Missouri occurs in the Mississippian Boone limestone, in rocks of Kinderhook age. The ore deposits are found in Jasper, Newton, Lawrence, Greene, and adjoining counties. This area produced in 1914 about three-fourths of the lead and zinc ore raised in the Joplin region.

The lead ores are galena, with a small quantity of lead carbonate, locally known as "dry bone." The zinc ores are sphalerite, or zinc blende, or "jack," zinc carbonate (smithsonite), and zinc silicate (calamine), both of the latter locally called "silicate." The galena contains but a small fraction of an ounce of silver to the ton of lead concentrates, and although ordinarily it is not desilverized, yet occasionally the refineries find it advantageous to add lead from the Joplin region to their charges without, however, making any record of the silver content. In this way an unknown but small quantity of silver is recovered from southwestern Missouri lead ore. The zinc ores, sphalerite, smithsonite, and calamine contain notable quantities of cadmium, being fully as rich in this respect as the zinc ores of Silesia, which are the source of the cadmium production of Europe. The discussion of the cadmium content of these ores is taken up more fully in the chapter entitled "Cadmium," in Mineral Resources for 1908.

The ore deposits of the Joplin district vary in character with the depth of mining. The shallower ores beginning at the surface are universally pockety and are found in residual clays or in "runs" in the basal breccias of the region. The breccias and the forms of the "runs" are largely, if not altogether, due to solution of the limestone strata. One form of run, which is fairly numerous, is the "circle" deposit, which, in the popular view, has come to be nearly synonymous with rich deposits. Small veins, vertical sheets, and thin crevice deposits are often met with in prospecting, but unless they develop into stringers leading into paying ore bodies are forgotten in the multitude of rich pockety deposits which the district has yielded. The blanket deposits or "sheet ground" are found in the Grand Falls chert member of the Boone limestone at depths varying from 100 to 275 feet, depending on the topography and the geologic structure. Below this horizon there are, in the rocks of Kinderhook age, deposits of disseminated ore. They have been found in prospect shafts or drill holes near Springfield, Aurora, Granby, Carterville, Joplin, Hornet, and Cave Springs, in Missouri; at Galena, in Kansas; and at Quapaw, in Oklahoma.

ORE PRODUCTION.

Mining and milling practice in the Joplin region is so well known through the numerous articles that have appeared in the mining press of the country that but few words are necessary here. The type of mill erected in the district is carefully chosen to fit the needs of the particular kind of ore body to be exploited and, being based on the evolutionary experience of nearly 40 years, is, in general, wisely selected.

In early days of zinc mining in the district, when only the richest runs and pockets of the "disseminated" deposits could be profitably worked and the life of the individual mine was necessarily short, a very simple type of concentrating plant came into use. It was equipped with a rougher jig and a cleaner jig and had a capacity of 80 to 100 tons of crude ore per 10-hour shift. When a deposit was worked out, the mill could be easily and cheaply moved to another deposit. When the increased price of concentrates made it possible to mine lower-grade ore, and the life of the deposits was thereby lengthened, somewhat larger and more complete milling plants came into vogue. Sand jigs and concentrating tables were added to the equipment, and the capacity was raised to 200 or more tons per shift. Such mills, developed by the necessities of local conditions, came to be characterized throughout the lead and zinc regions of the Central States as the "Joplin type."

A further increase in the price of concentrates and the development of large bodies of low-grade "sheet-ground" deposits, insuring permanence and stability of operation and necessitating every refinement of concentration, have resulted in the modern "sheet-ground mill" with capacity from 250 to 700 tons of crude ore per 10-hour shift, driven by steam generated by natural gas or driven by electricity, with complete equipment of ore-saving devices and with attendant economies of power, operation, and concentration.

For several years many of the concentrating plants used natural gas to produce power, but the rapidly declining supply and low pressure in 1912 and 1913 practically eliminated natural gas for fuel, especially in the winter season. Although coal is probably the cheapest fuel available for small mines having railway switches, there has been a large increase in the number of mining plants operated by means of electric power. Many of the largest and most efficient concentrating plants in the district have changed from steam to electricity, and independent motors are used for hoisting, for the concentrating plant, and for the treatment of slimes. Plants so equipped are enabled to operate economically the mine one 8-hour shift, the mill one or two 10-hour shifts, and the sludge plant continuously. There has been a noticeable increase in the number of slime plants and concentrating tables. This condition applies especially to operations in the "sheet ground," though "soft-ground" operators also have concluded that a large saving of concentrates is possible in most cases by the use of more tables to handle the fine ore. Some of the large producing mines like the Priscilla and the Duquesne, in the west Joplin camp, the American Davey, at Prosperity, and the Wilson, at Duenweg, have the sludge plants in a separate building and use an independent electric motor. At the Priscilla all the tailings from the

rougher, the cleaner, and the sand jigs are flumed to two concrete tanks, one of which is being filled while the other is drawn off. A hydraulic classifier with 8 pockets is used, so that each pocket feeds one table. The plant is equipped with 10 tables; the first 8 are fed by the classifier, and the overflow goes to two cones, each of which feeds a slime table. Although this plant has proved to be very efficient and has saved much ore, it is stated that more or less slime gets away in the overflow from the cones. An assay of this slime shows about 7 per cent zinc. More attention undoubtedly will be given to saving the finer particles of blende and galena in both "soft-ground" and "sheet-ground" operations, especially where the "dirt" is chatty and requires fine grinding and where the ore body is known to be large. Once an efficient sludge plant is installed the saving in concentrates materially increases the output at a very small additional cost for power and labor.

ORE SELLING.

As was noted in the introduction to this chapter, the lead and zinc ores of the Central States when marketed locally are sold on a plan which differs somewhat from the methods in vogue in the Western and other States where more complicated ores prevail. The producer is paid by the ton of concentrates, all output being sold in that form. The price is arranged on a sliding scale, the foundation of which is the price paid for ores of a certain standard, namely, the "basis."

In each of the ores a "basis" is arbitrarily taken which represents as nearly as may be the average metallic content of clean concentrate. In sphalerite or zinc-blende concentrate the basis is 60 per cent (theoretical composition, 67 per cent) metallic zinc, by wet assay or analysis; in the oxidized zinc ores, the carbonate and the silicate, the basis is 40 per cent (theoretical, 52 and 54 per cent) metallic zinc; and in galena concentrates the basis is 80 per cent (theoretical, 87 per cent) metallic lead. The buyer will offer so much for 60 per cent zinc ore, which becomes the "base price." If the assay shows the concentrates to vary from the basis, $1 is added to the base price for each per cent of zinc above 60 and $1 subtracted for each per cent less than 60. Deduction is made for moisture, all concentrates being sold on dry, or net, weight. Penalties are exacted for the presence of undesirable elements, as iron, bitumen, barite, fluorspar, etc. One dollar is deducted for each per cent of iron above 1 per cent.

Very little ore in the Joplin region is at present heavily penalized for iron. The concentrates from the Miami district derived from the upper run of ore were high in iron content, but for the last two years the quality of blende concentrates from Miami compares favorably with that of most of the other camps. Some of the ores from the Thoms Station district have had a greater iron content than other districts in Missouri. Bitumen has not been troublesome except in the early years of mining at Miami, though it has been noted in a small quantity of concentrates from a mine near Alba. The small penalty incurred in selling Joplin blende concentrates is shown from the composite assays of sphalerite furnished by W. George Waring, of Webb City, and W. W. Petraeus and Evans W. Buskett, of Joplin.

Fluorspar occurs in the zinc concentrates of western Kentucky and southern Illinois, but neither fluorite nor barite are found in quantity

in the ores of the Central States except in some mines in central Missouri and in a single mine in the Joplin district. The practice of buying zinc blende concentrates on an assay basis became general in 1899, though it began in a small way a few years earlier. Formerly the ore was bought on "flat bid"—that is to say, the buyer made a visual inspection and mental estimate of the metallic contents and then offered so much per ton for the particular concentrates in question. An expert buyer can estimate the metallic contents very closely. Galena concentrates are generally bought on flat bid, though buying on assay is increasing. Ore which is sold in lump, such as hand-picked galena, lead carbonate, and carbonate and silicate of zinc, is very generally sold on flat bid.

ASSAYS.

Several of the assayers in the Joplin district make a practice of saving the remnants of blende samples analyzed during the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which sample an average or composite assay for the year is made. Each assay thus represents several thousand lots. Two representative series of such composite assays are given below. In most cases each sample included in the composite assay represents a carload lot of concentrates.

The first series, by W. W. Petraeus and Evans W. Buskett, of Joplin, gives the result of analyses of composite samples from the general district for the last 15 years. The analyses for 1897–1905, inclusive, were published in the Lead and Zinc News, volume 9, page 8, January 15, 1906. The analyses for 1906–1913 were kindly communicated by Mr. Petraeus and that for 1914 by Mr. Buskett. Iron was not taken into account until 1900. Some 400 scattering assays, made in 1895–96, are excluded from the table

Composite assays of zinc blende from the Joplin region, 1897–1914.

[W. W. Petraeus, analyst, 1897–1913; Evans W. Buskett, analyst, 1914.]

Year.	Number of lots in the composite.	Percentage of zinc.	Percentage of iron.	Percentage of lead.	Percentage of copper.	Percentage of cadmium.
1897	600	56.64				
1898	1,299	56.99				
1899	3,715	56.67				
1900	3,500	57.36	0.22			
1901	3,683	57.53	2.02			
1902	5,776	57.08	2.24			
1903	6,014	57.30	2.00			
1904	6,220	57.24	2.10			
1905	4,628	57.97	1.84	1.00	0.001	0.198
1906	5,644	57.2	2.00			
1907	6,813	56.8	1.93			
1908	7,837	56.4	1.76			
1909	9,002	56.3	2.00			
1910	8,892	56.6	2.10	1.02	.06	.399
1911	8,920	57.1	2.40			
1912	9,474	57.7	2.40			
1913	7,010	57.1	2.40			
1914	420	56.40	2.70			

The next series of composite assays was communicated by Prof. W. George Waring, of Webb City. The original samples were of ores

from the different camps of the district except where otherwise indicated. The methods used in making these assays have been published.[1]

Composite assays of zinc blende from the Joplin region, 1900–1914.

[W. George Waring, analyst.]

Year.	Number of lots in the composite.	Zinc.	Iron.	Lead.	Cadmium.	Copper.
	Lots.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1900	3,894	57.30	3.03			
1901	5,172	56.00	3.30			
1901	2,577	55.30	3.86			
1901	[a]±2,000	55.90	3.47			
1902	2,270	57.08	2.65	0.904	0.337	0.050
1903	2,145	57.75	2.32	1.072	.388	.049
1904	[a] 3,800	58.26	2.23	.701	.304	.049
1904	[b] 2,691	58.46	1.97	.720	.430	.050
1904	1,984	58.95	2.10			
1905	4,520	58.95	2.00			
1906	4,638	58.40	2.20			
1906	3,968	58.20	2.29			
1907–8	±4,000	58.70	2.00			
1909		[c] 57.40	2.60			
1910	6,377	[c] 57.90	2.60			
1911	5,653	58.20	2.35	.856	.450	.034
1912	6,709	56.72	2.50	1.070	.256	.022
1913	7,364	56.82	2.81	1.112	.209	.036
1914	7,981	56.56	2.80	1.30	.287	.038

[a] Joplin. [b] Webb City. [c] The composite sample included some lots of silicate ores.

The complete analysis of the composite sample of the 3,800 lots of concentrate from the Joplin region in 1904, sampled by C. V. Millar and analyzed by Waring, is as follows:

Analysis of composite sample of zinc blende from the Joplin region.

Zinc	58.26	Calcium carbonate	1.88
Cadmium	.304	Magnesium carbonate	.85
Lead	.70	Barium sulphate	.82
Iron	2.23	Silica	3.95
Manganese	.01		
Copper	.049		99.773
Sulphur	30.72		

PRICES AND PRODUCTION.

It can not be stated that the year 1914 was a prosperous one for lead and zinc operators. Ore prices, which were not high at the beginning of 1914, sagged lower and lower until August, when a temporary rise took place. Then, in September and October prices of lead and zinc ore declined to the lowest point in several years, and owners of mining properties were very pessimistic. The advance in prices during November and December, especially in the price of zinc ores, resulted in dispelling the gloom, and new work was rushed to take advantage of prospective high prices. On the whole, production held up remarkably, notwithstanding the average price paid for sphalerite concentrates was $1.50 to $4 a ton less than the

[1] Waring, W. G., The Volumetric determination of zinc: Jour. Am. Chem. Soc., vol. 26, No. 1, January, 1904. In addition to the composite assays for 1902 and 1903, shown in the table, the article gives the lead, copper, and cadmium content of a number of ores from individual mines in Missouri, Kentucky, and Illinois.

price received in 1913 and $10 to $11 less than the average price in 1912. The decline in prices paid for lead concentrates was very much greater than in the selling price of zinc concentrates, for the average selling price of galena concentrates was $4 to $5 per ton less in 1914 than in 1913. This condition seriously affected the profits of the owners of "sheet-ground" mines in which the recovery is frequently 1 of galena to 4 of sphalerite. The reported sales of galena and lead carbonate and zinc silicate and carbonate concentrates from southwestern Missouri were considerably less than in 1913, and the shipments of sphalerite declined approximately 36,000 tons. It is customary to sell the galena concentrates and the zinc silicate and carbonate as soon as possible, and there is seldom any accumulation of these classes of ore, regardless of the prices prevailing. Thus the sales of these classes of ore may be regarded as the approximate production for the year, as even the low prices in 1914 did not result in any large stocks accumulating. When prices offered are considered low, some sphalerite (though it seldom is more than the normal output for one or two weeks) is held for higher prices, so that the production of sphalerite in southwestern Missouri was probably 12,000 to 13,000 tons in excess of the reported sales of 189,725 tons.

Prices for zinc concentrates showed steady low ranges for about eight months, with temporary comparatively high prices during August and September. The average quoted base price for 60 per cent blende concentrates was highest during the last three weeks in December, when the base price quoted was from $51 to $52 a ton. In the first week in January, 1914, the price was $43, declining to $41 and $37 three weeks later. In February the base price advanced as high as $43.50. During March, April, May, June, and July the weekly base price remained about $40, declining to as low as $35 for some ores. Prices advanced gradually in August as high as $50, then steadily declined during September and October until $35 to $40 was the average price. The price declined slightly the first part of November and then began the rapid advance to the high prices prevailing at the end of the year. The average price was lowest during certain portions of May and October, and there was considerable variation in the prices offered for high-grade and low-grade ores. The approximate highest base price during the year was $50 to $52 and the lowest $35 to $38.50.

Base prices for calamine or zinc carbonate and silicate concentrates followed generally the variations in sphalerite quotations and were lowest, at $16, in April and highest, at $25, in August and December. The quoted prices for 80 per cent galena concentrates were subject to a much wider fluctuation than usual. The market opened in January at $48 a ton, advanced to $50 a ton one week later and held steady until the middle of March, when it declined to $48 and further declined to $45 in April. In May the quoted price advanced to $46 and remained at that figure until October, when it declined sharply to $40. In November the price advanced to $42 and then to $47 and held steady until the end of the year.

The average price paid for sphalerite or blende in 1914 was $38.74, as compared with $40.70 in 1913 and $50.44 in 1912 and for zinc silicate or carbonate concentrates it was $21.13 in 1914, $22.45 in 1913, $28.95 in 1912, $23.76 in 1911, and $23.58 in 1910. The average

price paid for galena concentrates was $46.83 in 1914, as compared with $51.50 in 1913, $55.36 in 1912, and $55.75 in 1911. These prices are not average base price quotations, but are the actual average prices calculated from the tonnage sold and the values reported to the United States Geological Survey by the sellers.

The prices received by the producers show that the average actual selling price of sphalerite in 1914 was $1.96 a ton less than in 1913 and $11.70 less than in 1912, and that the corresponding decrease in prices for zinc carbonate and silicate in 1914 was $1.32 per ton.

The average metal content of sphalerite concentrates derived from "soft ground" increased from 57.5 per cent in 1913 to 57.9 per cent in 1914, and of those derived from "sheet ground" from 58.3 in 1913 to 58.4 per cent in 1914. The average metal content of the galena concentrates derived from "soft ground" was also more in 1914 than in 1913.

The recovery of sphalerite and galena concentrates from "sheet ground" was approximately the same for the years 1910, 1911, 1912, 1913, and 1914, indicating clearly that about 2.6 per cent of concentrates is what may be expected as the approximate recovery for a term of years from this class of deposits. The average recovery of concentrates from "soft ground" increased from 3.87 per cent in 1912 to 4.56 per cent in 1913 and to 4.61 per cent in 1914, showing that the tendency was to mine "dirt" carrying a larger quantity of lead and zinc, which was a natural result of the lower prices paid for concentrates during the years 1913 and 1914.

The total tonnage of ore or "dirt" treated decreased from 8,049,300 tons in 1913 to 6,774,000 tons in 1914. The ore treated from "sheet ground" was 3,594,170 tons, a decrease of more than 700,000 tons, and that from "soft ground" was 3,179,830 tons, a decrease of about 565,000 tons.

In 1914 the sphalerite concentrates derived from the "sheet ground" mines amounted to 80,228 tons and the galena concentrates to 15,868 tons. In 1914 the "soft-ground" mines yielded 109,537 tons of sphalerite, 15,164 tons of galena, and all of the lead carbonate, zinc, silicate, and zinc carbonate concentrates. The total value of all concentrates derived from "sheet-ground" mines was $3,869,690 and from "soft-ground" mines, $5,353,774. This shows that the value of the production of concentrates from "soft ground" amounted to about $1,484,084 more than the production from "sheet ground", although the ore or "dirt" milled or otherwise treated was 414,341 tons less in quantity.

The value of the production from "sheet-ground" mines in 1914 was $1,051,208 less than in 1913 and that from "soft-ground" mines about $1,281,057 less.

The radical change from very high prices paid for concentrates in 1912 to low prices during most of 1913 and of 1914 was naturally reflected in the decreased output of about 24,000 tons of sphalerite and 4,000 tons of galena derived from "sheet ground" in 1913 and a further decrease of 12,784 tons of sphalerite and 4,521 tons of galena in 1914. The low prices operated in two ways to affect a decreased output from "sheet ground"—first by the closing down of mines when the cost of production was in excess of $40 to $45 a ton of sphalerite, for few "sheet-ground" mines can be operated profitably when sphalerite prices are at $40 a ton and practically none at $35,

particularly when lead prices are as low as $46 a ton; second, by the exhaustion of the ore bodies in a number of "sheet-ground" mines which was not compensated for by the opening of new mines of a similar character.

In 1913 the operations of some rich "soft-ground" mines increased the output and partly compensated for the lessened activity in the "sheet-ground" mines. The continued low prices in 1914 restricted the equipment of new "soft-ground" mines and also caused practically all mine owners to operate a single 8-hour shift. In consequence there was a reduction in the output from "soft ground" of about 23,000 tons of sphalerite and 1,000 tons of galena concentrates. Low-priced ore in the Joplin district has always resulted in increased prospecting in "soft-ground" camps. Miners thrown out of employment who are unwilling to accept the wages automatically reduced by lower ore prices obtain leases and prospect for ore bodies suitable to work by means of hand jigs or to develop sufficiently to sell to large operators. Continued low-ore prices, however, restrained investment in most of such prospects until late in the year. In December many old and new mines were being hastily equipped and second-hand concentrating plants were eagerly sought, so that the year that opened with dullness ended in hopefulness and activity.

One result of the long-continued era of low prices was a reduction in the royalty on leases made by many landowners. Some of the new leasing contracts stipulated a graded royalty based on prevailing ore prices. Such leases are most equitable, for a low royalty is an incentive to prospecting, and when ore prices are high a large royalty is not burdensome.

The Webb City-Carterville-Prosperity district, which includes many of the "sheet-ground" mines, was again, notwithstanding conditions, the largest producer of both blende and galena concentrates in southwestern Missouri. It produced 57 per cent of the galena concentrates and more than 34 per cent of the sphalerite sold in 1914. In 1913 it produced 60 per cent of the lead and 34.3 per cent of the sphalerite.

The quantity of crude ore or "dirt" raised is a better indication of the extent of mining activity than the production of concentrates, for the "sheet-ground" ore is of lower average tenor than the "soft-ground" ore. The leading position of the district is more adequately shown by the fact that the estimated quantity of ore mined in the Webb City-Prosperity district in 1914 was about 2,993,900 tons, or nearly 43 per cent of the total tonnage of crude ore raised in southwestern Missouri, although the tonnage in 1914 was nearly 650,000 less than in 1913.

Joplin, the second most productive district in 1914, showed an increase in galena concentrates of about 500 tons, and in zinc carbonate and silicate of 600 tons, and a decrease in blende concentrates of 5,600 tons. This would seem to indicate that shallow mining for lead and silicate was more active than mining at deeper levels. About 100,000 tons of the blende concentrates out of a total production of 189,725 tons, and about two-thirds of the galena concentrates, were shipped from the two districts.

The Alba-Neck City district by reason of its large yield of high-grade galena concentrates advanced from fifth place in 1913 to third place in 1914. Its yield of sphalerite was 5,000 tons greater than

that of the Duenweg-Porto Rico district, and exceeded its 1913 production by more than 8,000 tons, giving it the distinction of being one of the few districts having a larger yield in 1914 than in 1913. The Duenweg-Porto Rico district was fourth in value of production, Oronogo fifth, Granby sixth, while Thoms Station, with a decreased production, amounting to over 12,000 tons, dropped from fourth to seventh in rank. The only districts showing an increased output in 1914 were Alba-Neck City, Granby, and Springfield.

Development work, which makes possible larger outputs in 1915, was especially noteworthy in the Webb City-Carterville, Joplin, Duenweg, Oronogo, Granby, Aurora, and Springfield districts. The most important developments during 1914 are described under the various district reviews, which are given with less detail than in 1913. They give, however, the new work accomplished, the new concentrating plants erected, and other important changes. A full list of mines and descriptions of the older concentrating plants, surface equipment, and underground workings are given in the report for 1913, copies of which can be had upon request to the Director of the United States Geological Survey.

REVIEW BY DISTRICTS.

Alba-Neck City district.—The shipments of sphalerite from this district in 1914 increased about 8,300 tons and those of lead ore about 100 tons. There were also large shipments of zinc silicate, which are not of usual occurrence from this portion of the region. The total value of all concentrates sold was about $1,075,000, or $350,000 more than the value in 1913, when prices were much higher. The mines in the vicinity of Alba and Purcell produced a comparatively small part of the yield, and the increased output was mainly due to mines in Neck City and to the mines northwest of Neck City. About 15,000 tons of sphalerite concentrates were derived from the Century, Longacre & Chapman, Lucky Tiger, Jessie, and Annalinda mines, and more than 7,500 tons from the Quick Seven, Little Mary, and other properties northwest of Alba, and the remainder of the output from the Alba-Purcell camp. There are a number of mines, including some in the Springfield, Cave Springs, and Joplin districts, which yield sphalerite concentrates having a zinc content above 61 or 62 per cent, but no district having a large output marketed sphalerite concentrates of as high grade as those from Alba-Neck City, which averaged 59.7 in zinc content. In 1914 the average zinc content of sphalerite from "soft-ground" mines in southwestern Missouri was 57.9 per cent, and the average selling price of sphalerite concentrates was $38.74 a ton. The excellent quality of most of the Alba-Neck City zinc concentrates had the natural effect of making the average selling price more than $3 above the average price for the region. The most productive mine in the district, and one of the most productive in Missouri, was that of the Century Mining Co. on the Longacre & Chapman land. The recovery of sphalerite concentrates from the small leasehold mined has been seldom exceeded in Missouri. The "dirt" milled yielded an average recovery of about 12 per cent in 60 per cent concentrates, and the tailings are said to contain approximately 3 per cent. The high recovery of concentrates from "dirt" made the mining very profitable, even at the

low prices prevailing. Two 190-foot shafts were used to obtain the ore supply for the 150-ton mill.

Mines on the Reliance land adjoining the Century mine produced the second largest yield in the district. Of these, the Longacre & Chapman Mining Co. had much the largest output. The ore mined was similar to that at the Century, and the shafts are about the same depth. The mill recovery at the 200-ton plant was slightly lower than at the Century, but the concentrates had a higher zinc content. Other producers on the Reliance land in 1914 were the Annalinda, Elliott & Long, and Greene & Co. mines and the Jessie Milling Co., and development work was done by S. L. Bradley and the Blue Bird Mining Co.

The production of the Quick Seven lease on the Richardson land was again one of the largest in Missouri. The concentrating plants contributing to the production were those of the Quick Seven Mining Co., the Progressive Mining Co. (1909 mine), and the Hub Mining Co. (Texmo mine). Some of the sphalerite sold by the Progressive Mining Co. had a zinc content of 63.5 to 64 per cent, and was practically free from iron or lead.

The land of the Penn Zinc Co. was more actively worked than in the year 1913. The Lucky Tiger Mining Co. opened a new mine and erected a 200-ton concentrating plant, which milled ore taken from the 220-foot level. The old Rubberneck mine was reopened by the Dollie C. Mining Co. after the ground had been drilled and a new 90-foot shaft had been sunk. The concentrating plant was also repaired and new equipment installed.

Other producing properties in the Neck City camp were the Red Brush mine on the Seward & Gill land, Gould & Co. on Cliffwood land, Bull Dog Mining Co. on Calumet land, and the Little Mary on the Weaver land. Of these mines the output of the Little Mary was much the largest. The production of sphalerite from the Alba section of the district was made partly by the Alba Tailing Co. on the Fox land and the Jumbo Tailing Co. on the Sponable land, but mainly from subleases of the Davidson Joplin Mining Co. on the Aylor, Fox, and Wheeler lands. About nine shafts and three milling plants were in operation in 1914. The productive leases were the Sunflower Zinc Co., which erected a modern 200-ton concentrating plant in 1914, the Battle Axe, Little Red, and Cathers. Most of the zinc silicate sold in 1914 came from the Jones & Co. lease on the Stewart land. The ore mined was treated by means of hand jigs, and the output of this class of ore was much larger than is usual in the district.

Ash Grove-Everton district.—The mining in this vicinity is all shallow, none of the workings exceeding 50 feet in depth. The ore is raised by means of horse whims and cleaned on hand jigs. Most of the lead was mined on the Duncan land in Boone Township by Meidinger & Co. and Brooks & Co., and shipped by E. A. Hurt. The zinc carbonate and silicate produced was mainly the output of the lessees on the John A. Hall land near Corry.

Aurora district.—The production of lead concentrates of this district in 1914 was about the same as in 1913. The output of zinc silicate and carbonate increased 15 tons, but the production of sphalerite declined 85 tons. A large part of the output was made by lessees working shallow ground, the crude ore or "dirt" being treated

at custom mills or sold in the rough. Most of the mining was on a small scale. The sublessees of Stratton Bros. and of the Chat River Mining Co. produced a large part of all the zinc silicate "dirt" mined in the district. This "dirt," which is hoisted from above the 40-foot level, was sold in the rough to chatting plants, as there was no concentrating plant on the United Zinc Co.'s land.

Although the production at Aurora in 1914 was even less than in 1913, development was more active. It was realized that if there was to be any large increase in output, it was necessary to prospect for ore at deeper levels and to lower the water level so that shallow ground mining could be increased. Money was raised for prospecting, and several drilling outfits were operated by the American Zinc Lead & Smelting Co. on various lands. Pumps were also started on several tracts, and it is stated that the old No. 4 Drill Co. mine on the Robberson land, which has one of the deepest shafts in the district, will be operated again. The work done in 1914 had little effect on the output, but it will probably result in a much increased production in 1915.

The Boston Aurora tract was purchased by C. C. McCormick, and the old Federal land and mill by George R. Tooker.

A large portion of the output of Aurora was shipped by C. C. Plank, who manages or controls the Milton Mining Co., Midland Mining Co., Chat River Mining Co., and Cleveland Aurora Mineral Land Co. Another prominent producer was E. K. Johnson from the Decatur and Sedalia lands. Other producing companies in the district in 1914 were the Black Land & Mining Co., Murray & Stewart, and the Missouri Hydraulic Co.

Carl Junction district.—The production of lead concentrates in the district decreased 120 tons and that of sphalerite concentrates 6,760 tons. This large decrease was caused by the curtailed operations of the Chicago Lehigh Mining Co. on the United Zinc Co.'s lease of the Avondale and Knight lands and the United Lehigh lease of the Ishpeming land. The Chicago Lehigh Mining Co.'s output of sphalerite concentrates came from ore mined at the 140-foot level by means of two shafts (the Ishpeming ground being worked through the Knight shaft), and the concentrating plant was operated from January to September, when it was closed down. Other producing leases on the Hall lease of Avondale ground were the Webb City Lehigh and Hayes & Co. On the Smith lease of Avondale land some production was made by the Gager Mining & Milling Co. and the Dallas Mining Co.

The output of the Moler Smith Lead & Zinc Co. was much less than in 1913.

Other producing mines in 1914 in the Carl Junction district were the Park Land & Mining Co., Rowend & Co., M. S. Arment, and Clary & Co. Some concentrates derived from tailings of the Weaver mine on the Anderson land were shipped before the mill was destroyed by fire. The large shaft of the Galena Joplin Lead & Zinc Co. was sunk to a depth of 200 feet, and two pumps were installed to handle the strong flow of water. Another shaft is being sunk, and the construction of a mill is probable.

Carthage district.—Reports from this district showed that the production of lead concentrates increased 5 tons and that of sphalerite decreased 500 tons in 1914, as compared with 1913.

The Hermosa Mining Co., on the Amsden land, 2½ miles northwest of Carthage, was the only large producer in 1914. The 200-ton mill was run steadily up to September on ore hoisted through 2 shafts, one 70 feet deep and the other 175 feet.

Nearly all of the zinc silicate ore was shipped from the Cobaugh sublease of the Lone Star Mining Co. on the Bergner land. The ore was all obtained by means of shafts 16 to 50 feet in depth. The G. M. Mining Co. produced no concentrates in 1914, though several shafts were sunk and drilling operations were continued. It was reported that good ore bodies had been located at 60, 130, and 160 feet on the western portion of the tract.

Cave Springs district.—The production of galena concentrates decreased from 181 tons in 1913 to 105 tons in 1914, and the production of blende concentrates decreased from 3,331 tons in 1913 to 2,652 tons in 1914.

The decrease was due to the fact that the lower levels of the Miami Realty & Mining Co. lands were not worked. The number of productive leases and small mines increased, and considerable drilling or development work was done. The Cave Springs Lead & Zinc Co. holds leases not only on the Miami Realty & Mining Co.'s land but also on the Schmidt & Schemmerhorn land. Both tracts were mined by sublessees, and the holding company installed pumps at the Kramer mine and drained the upper levels, which are now being worked. The lower levels will also be unwatered and mining resumed. One of the best small mines producing in 1914 was that of the Grass Roots Mining Co., which recovered the largest output of the district by means of two shafts less than 50 feet in depth.

Producers on the Cave Springs Lead & Zinc Co.'s lease and on the McCullough & Murdock lease were Norman & Co., Cooper & Co., Newton & Co., J. Cole & Co., Bailey & Co., Johnson & Co., Simms & Co., Newman & Co., Ohio Missouri Prospecting Co., Morgan & Co., and the White Oak Mining Co. All of the ore from these mines was treated at the M. Grundler and Charles Lau custom mills, each of which has a capacity of 75 to 100 tons per shift. The Big Brownie mine and mill were leased to H. H. White and others, and preparations were made for resuming work.

Duenweg-Porto Rico district.—Though this district is one which contains a number of "sheet-ground" mines, some of which, including the Vogey, were idle in 1914, the decrease in output was not large. Moreover, the decrease can not be attributed to the "sheet-ground" mines, for their output in 1914 was 1,558 tons of galena concentrates and 13,381 tons of sphalerite as against 1,672 tons of galena concentrates and 12,658 tons of sphalerite in 1913. The district production of sphalerite declined from 20,075 tons in 1913 to 19,526 tons in 1914, and the quantity of galena concentrates decreased from 4,051 tons in 1913 to 3,176 tons in 1914, and the quantity of zinc silicate from 1,991 tons in 1913 to 169 tons in 1914. The lead production in 1913 was abnormally high on account of the large shipments made from the Walker land, so that the decline in galena was normal. The reduced output of zinc silicate was caused by the closing down of the old Central States mine on the Hall land and the failure to develop other deposits of ore of this character. The Hall land was again actively worked in December, so that the zinc silicate

production for 1915 will more closely approximate that of former years. The "sheet-ground" mines produced about 50 per cent of the lead and 68 per cent of the sphalerite. About one-sixth of the galena concentrates recovered from "soft ground" came from mines on the Walker land. The largest producers of sphalerite concentrates in 1914 were the Coahuila, Gopher (Lincoln), Wilson, and What Cheer mines, in the order named. Most of the zinc silicate was produced by lessees of the Hall and the Saddtler Lead & Zinc Co. lands.

As the development in all the present "sheet-ground" mines was favorable and the old Vogey and other mines have been reopened, the 1915 output should be very much larger.

The Coahuila Mining Co. on the Horton land worked a 30-foot face of ore in "sheet ground" at 240 feet. The concentrating plant has a capacity of 300 tons and is fully equipped with tables to save the fine ore, and the production was considerably larger than in 1913. The production of the Gopher Mining Co. from the old Lincoln mine on the Jasper Royalty Co.'s land was about the same, though the mine was only operated single shift after April.

The production of concentrates from the land of the Boston-Duenweg Mining Co. was larger in 1914 than in 1913. Most of the output was due to operations by the Wilson Mines Co., which hoisted ore from a depth of 172 feet by means of two shafts. Considerable drilling was done on the Wilson lease, and a shaft is now being sunk by the Vinegar Hill Zinc Co.

The Vogey mine of the American Lead & Zinc Co. was idle in 1914, but since the increase in the prices paid for sphalerite, the mine has been unwatered and operated. A part of the adjoining land, owned by Dougherty & Lyons, has been leased, and the face of ore now being cut will be extended to that land as the ore body on the Vogey is nearly exhausted. The Grand Haven land was idle in 1914, but has since been purchased by the Rideau Mining Co., which is now selling concentrates. The producers on the Baker land were the Melrose mine and the What Cheer mine, which were developed late in 1913. Hugh Correll operated the Melrose mine on "sheet ground," and the What Cheer ore body is also of that character. The last-named mine has two shafts 208 feet deep and a mill of 200 tons capacity. The Van Dorsser land only had a small output, but the Porto Rico mine was equipped with a concentrating plant in December, and other leaseholds were drilled. The producing mines on the Walker land were the Sayer Mining Co., Duenweg Lead & Zinc Co., Little Bob Mining Co., and the R. L. McGee Mining Co. The McGee mine was sold in July to George W. Moore and the production was largely increased during the last half of 1914. A large tailing plant is being erected on the Douglas & Anderson lease of the Chew land. The land was mined by several lessees and the output was considerable, although the small mill on the property was burned in August. Sales of concentrates were also made by lessees on the following lands: American Lead & Zinc Co. (December tract), Cunningham & Kane, Carrick, Crown Crest Zinc & Lead Co., Old Colony Zinc Co., Royalty Land & Mining Co. The only production from the Diamond and the Scotland camps was a small quantity of lead and zinc silicate from the Weymann and the Gregg lands. Some of the mines under development which will probably ship concentrates in 1915 are the Genessee on the Chase land, the Scott on the Ground & Irwin land, the Open Air on the

Crown Crest land, the Kersey on the Largent land, the Hawkeye on the Jones land, and the Try Again and Purciller on the Stevison land.

Granby district.—The output of sphalerite concentrates in this district in 1914 was more by 1,578 tons, and that of lead concentrates less by 29 tons, than in 1913. The production of zinc carbonate and silicate concentrates decreased 310 tons. More than 54 per cent of the output of zinc carbonate and silicate concentrates from the Joplin region came from the Granby district. Some ore was derived from the J. B. Davis and the St. Paul Mining Co.'s lands, but most of the producing territory belongs to the Granby Mining & Smelting Co. The total production was large, the relative quantities of zinc silicate, zinc blende, galena, and lead carbonate being in the order named. Much of the mining by small companies and by individuals is in shallow workings that yield galena and zinc silicate ore. The larger producing lessees on the Granby lands were the Broken Hill Co., Golden Rule Mining Co., Jack Snipe Mining Co., Little Boss Mining Co., Katy Mining & Milling Co., J. R. Underwood Mining Co., Billiken Mining Co., Granby Sludge Co., Automobile Mining Co., Little Boss Brotherhood Mining Co., Hash Richardson Co., Fortune Teller Mining Co., Local Mining Co., Pierson-Cook Mining Co., Trilby Mining Co., A. A. Bilyea, Cook & Co., Ferguson & Waughtell, Lemons & Arnall, Waterworks Mining Co., and Fee Simple Mining Co. The depth of mining varied from very shallow openings to 215 feet, and 10 concentrating plants were operated.

The 200-ton concentrating plant of the Granby Mining & Smelting Co., the largest in the district, is so equipped that it can be used to concentrate either blende or calamine ore. Many of the lessees on this land have no concentrating equipment and a large quantity of ore is treated at custom mills or sold in the rough.

Several churn drills were in operation on the Granby land, and considerable bodies of ore were definitely located at levels much lower than that at which operations are now conducted. The Granby Mining & Smelting Co. is now building a 400-ton mill to handle the new ore body located south of the town.

The Mascot and Homestake mines reopened by the Underwood Mining Co. were actively worked and the 300-ton mill was practically rebuilt. Mining in 1914 was done at the 230-foot level, but the shafts are 250 feet deep and the ground at that level was being opened.

The production from the Davis land and from the St. Paul land was very small in 1914.

Joplin district.—The change in the classes of ore shipped from the Joplin district indicated clearly the effect of low prices, and on the whole showed that discouraging conditions did not result in a seriously reduced output and that, though such conditions did reduce the output made by some large mines, the number of small operators increased. Many of the mines near Thoms Station, Klondike, and other camps are locally classed as belonging to the Joplin district and their output is included with that of Joplin, and in considering the relative output of Joplin camp, compared with that of the eastern and the extreme western districts of the Joplin region, the output of these camps must be taken into consideration.

The district easily retained its place as the second largest producer in southwestern Missouri. The sales of concentrates in 1914 were

as follows: Galena, 4,407 tons, valued at $201,573; lead carbonate, 93 tons, valued at $2,089; zinc blende, 36,437 tons, valued at $1,403,476; zinc carbonate and silicate, 2,080 tons, valued at $42,063. As compared with 1913 the sales in 1914 of lead concentrates increased 431 tons and that of zinc silicate and carbonate 623 tons; the sales of zinc blende decreased 5,624 tons, and the total value of all concentrates sold decreased $368,171. About 65 per cent of the zinc blende and 89 per cent of the galena concentrates were recovered from ore mined in "soft" ground.

The per cent of recovery of concentrates from "sheet ground" was only slightly less in 1914 than in 1913, for although the Falls City mine was idle and the output from the Geronimo and Priscilla mines was less than in 1913, there was an increased yield from the A. W. C., Otis, and Symmes mines. The "sheet-ground" production will probably be much larger in 1915, as the Falls City, Martha Ball, Samson, and Muskingum mines are being unwatered and new concentrating plants are now milling ore or are under construction on the Luke, Connor, Deering, Expansion, and Lambert lands.

In general the mines in the immediate vicinity of Joplin were less active and had a smaller production in 1914 than in 1913. There were many idle or partly operated mines near Chitwood and Smelter Hill, though considerable shallow mining was done on the Lone Elm lease of the Picher and Granby lands, and the Granby Mining & Smelting Co. developed a good mine and erected a large mill for company operations at Chitwood. The St. Louis Joplin tract was under development by several new leasing companies and new concentrating plants were built. There was more mining than in 1913 on the Lambert, Luke, and Expansion lands in the West Joplin camp. Operators at Gordon Hollow were less active and the production was less than in 1913.

The value of the lead and zinc concentrates from lands owned by the Connor Realty Co., north and west of Joplin, was greater than that mined from the property of any other landowner in the district, though the mines on Granby, Continental, and Boruff lands produced more galena. The Connor land near Chitwood yielded less concentrates than in 1913, and the larger portion of the shipments were made by mines operating on the Central City tract. The Long mine (formerly LoJa), partly on Granby land, was operated by D. G. King, and was much the largest producer on the Chitwood tract. At Central City, F. A. Hornaday not only operated a mine but milled large quantities of custom ore for sublessees, including Childress & Messenger, Flynn & Co., May & Co., and Mitchell & Co. Five shafts were operated on the lease, which was one of the largest producers of ores from shallow workings in the district. Considerable hand-cobbed galena and zinc silicate was sold, and hand jigs were also operated by several of the lessees. The Geronimo and Priscilla mines of the Underwriters Land Co. were the largest producers of sphalerite on the Connor land.

The production of lead concentrates by lessees on the Joplin tracts of the Granby Mining & Smelting Co. was the largest in the district and that of zinc concentrates was only exceeded by the output from the Connor land. The owners of the land did considerable prospecting and development work and erected a 200-ton mill at the B. & H. mine. The average depth of mining by Granby lessees was 140 feet, and other

producing mines on the Granby lands were the Amalgamated, Bay State, Lone Elm, King, Howerton & Williams, Gross, Omega, and Grace; also the Connecticut and Pearl tailing mills.

A new 150-ton mill was built by the Kentucky Lead & Zinc Co. on the St. Louis Joplin land, and concentrates were shipped after August. The Bradley Lead & Zinc Co. and the Dutchman's Choice Mining Co. both did development work on adjoining leases and were engaged in erecting mills. The 1915 ouput of the St. Louis Joplin land should show a large increase.

One of the prominent "sheet-ground" producers was the A. W. C. Mining Co., which operated one mill at the old Hero mine on land of the Banner Investment Co. and another plant on the adjoining land of Luke & Ash. Another mill on the Luke & Ash land was under construction, which makes the A. W. C. Mining Co. one of the largest operators in the district. A 200-ton tailing mill was also built by Bendelari & Longacre on the Luke & Ash land, which will run on tailings from the Hero mine. Part of the land was sold to the H. & F. Mining Co., and after drill prospecting two shafts were sunk to the 200-foot level and a 250-ton concentrating plant was built. In addition to work done on the land owned in fee, an adjoining 80-acre lease was prospected in 1914.

Other mines operating on the West Joplin "sheet ground" were the Otis, on land of the Expansion Realty Co., the Symmes, on Lambert land, and the Duquesne, on Mattes land. The Otis has a 300-ton mill which ran steadily after April, 1914, but the Duquesne plant was not operated as steadily as in former years. A very extensive separate sludge plant was built at the Duquesne.

The Purciller lease on the Mattes land was sold to the Handford Mining Co. and "sheet-ground" ore was milled at the 200-ton plant until it was destroyed by fire in July. The mill was rebuilt and was in operation early in December.

The equipment at the Symmes mine was remodeled in 1914 and a good production was made. The Lambert land, on which the Symmes mine is located, was successfully drilled for "sheet-ground" deposits, several new shafts were sunk, and some lessees have contracted to erect concentrating plants.

One of the favorable features of the year was the increased production of galena and blende development made from leases on the Continental Zinc C.'s land. The yield of galena gave the Continental land second place for lead production. The producing leases were the Temagami, Brown, Jack Harvard, Captain, Little Pearl, Bippo, Roadside, and Kittrel.

Amongst the new mines opened or new concentrating plants erected in 1914 were the following: The Baldry lease on the Boruff land, a large new producer of galena and zinc silicate concentrates; the Wise Guy tailing plant of 200-tons capacity, which was moved from Carthage to the Dirigo land; the A. F. Ford & Co. lease on the Gray land, on which two shafts were sunk and a 50-ton mill was built; the Once More Mining Co., which developed a mine on the Metzler land formerly leased to the Hackett Mining Co. (the 75-ton mill was run on ore from the upper ground and not from the "sheet ground" formerly worked); the old Cock Robin and Pelican mines on the United Zinc Co.'s land at Chitwood were drained by T. B. Osborn, and a 100-ton mill was built, which was utilized to mill dirt hoisted from both mines.

Other producers in 1914 not previously referred to were the Adirondack; the Lee Hall and the Red Lion mines on the Anderson land; lessees on the Butts, Campbell, Cox, Foss, Keller, Crellar, and Home Land & Loan Co.'s lands; the Anderson lease on the Irwin land; the Burke Mining Co. on the Johnson land; the Morsman lease on the Henderson land; the Economy Mining Co. and the Blanch May Mining Co. on the Marion Land Co.'s property at Gordon Hollow; the Hillside Mining Co. in the same locality; various lessees of the Missouri Lead & Zinc Co., Montgomery Lead & Zinc Mining Co., Paomo Mining Co., Pittsburg Joplin Lead & Zinc Co., Rex Mining & Smelting Co., Roaring Springs Land & Mining Co., Mossback Land & Mining Co., J. B. Robb, Inter City Mining Co., Saginaw Investment Co., P. L. Swartz, Ten Per Cent Prospecting Co., United Zinc Co., Playter Bros., and Shoal Creek Mining Co.

Two new companies which did considerable development work and produced small quantities of concentrates in 1914 were the Cross Roads Mining Co. on the Paul land and the Woodlawn Mining Co. at Royal Heights.

Oronogo district.—In 1914 the production in Oronogo district of lead concentrates increased 220 tons and that of zinc blende concentrates decreased 2,551 tons as compared with the output in 1913. Most of the producing territory in the district has been owned for many years by the Granby Mining & Smelting Co. Little of the "dirt" came in 1914 from workings above the 70-foot level, and nearly all of the production was made by three or four companies. The most prominent producer on Granby land was the old Oronogo Circle mine, which had a larger output of blende concentrates than any other mine in Missouri. Ore was hoisted from 8 shafts in the first part of the year and from 4 shafts in the last part.

The other producers on Granby land in 1914 were the New Year Mill & Gravel Co., the Morning Star Sludge Co., the Pinnacle Mining Co., Lucky Strike Mining Co., Mannon & McGee, Geer & Co., and Sloniker & Co.

The lands now leased to the Oronogo Circle Mining Co., which cover about 126 acres, have been mined for many years, and the zinc ore output of the mine is stated not to have been exceeded by any mine in the United States except the Sterling mine of the New Jersey Zinc Co., in New Jersey. Caving ground somewhat reduced the yield in 1914, but the damage is not considered serious except for the loss of time involved. During the year the controlling interest held by Moore & Platt was transferred to Turner & Co., who expect to mine the ore bodies eventually by the open-pit method. There was considerable drilling done upon lands near Oronogo, but the most interesting event was the purchase of the Old Judge property on the Elliott land by the Oronogo Mutual Mining Co. The company also acquired the mining rights of many city lots and purchased the Hockaday tract from the American Zinc, Lead & Smelting Co. The Old Judge concentrating plant was practically dismantled and a new electrically driven plant was built from parts of the Old Judge and the New Year mills. Two sets of extra jigs for the reconcentration of chats, 11 tables, and additional slime tanks were added to the equipment. Two shafts 165 to 170 feet deep were used to hoist ore in 1914 and a new shaft was being sunk on the lease of the city lots. The development in 1914 underground was along the western face

of the Old Judge and along the northern and the southern lines. The mill was completed and operated for about three months and the production for that period indicates that the mine will have a very large yield of high-grade sphalerite concentrates in 1915.

Sarcoxie-Reeds district.—The production of this district, which was entirely of zinc blende and zinc silicate in 1914, was less than half as large as it was in 1913. The Reo mine on the Mercantile land, 3 miles west of Sarcoxie, was in operation for part of the year and was the largest producer of blende concentrates. The only production from the Henry B. Boyd land was a small quantity of zinc silicate. E. R. Grieb also mined zinc silicate on land of the J. P. Boyd estate. The only other producing property was that of the Sun Mining Co. at the Cameron mine on the J. W. Boyd land. Ore at the 190 and 230-foot levels was mined by means of two shafts, and new boilers and a compressor were added to the surface equipment. The mine and mill were sold in December and are now being operated by the Lower Level Mining Co.

Thoms Station-Sherwood district.—In 1914 this district produced 586 tons of lead concentrates and 12,164 tons of blende concentrates less than in 1913, and dropped from fourth to seventh place among southwestern Missouri districts. The output of lead concentrates in 1914 was 846 tons, valued at $39,217, that of zinc blende concentrates was 9,536 tons, valued at $327,000, and that of zinc silicate 18 tons, valued at $154. There were quite a number of small mines developed in 1914 and ore was recovered by means of hand jigs. The district has been noted for its rich but small ore bodies. The large reduction of output was not due so much to the smaller number of mines worked as to the comparatively small yield of the Pocahontas, Powhatan, and Sitting Bull mines. The aggregate output of these mines in 1913 was 12,839 tons of sphalerite and in 1914 their output was only 1,686 tons, most of which was shipped by the Powhatan on the Madison land. The production of the Sitting Bull was nominal, and the fire in the drifts of the Pocahontas forced the owners to flood the workings. The idleness of these properties not only affected their production but also checked development and prevented the mining of ore in the lower levels of adjacent mines until adequate pumping facilities could be provided.

The Napoleon mine on the Perry land was the largest producer of both galena and sphalerite in 1914. The ore mined by means of 2 shafts came from the 175-foot level in very soft ground that required careful timbering. Some drilling was done and an aerial tramway 450 feet long was built. The 250-ton concentrating plant at the Powhatan mine was operated part of the year and made the second largest output in the district. A new 100-ton plant was built on the Alamo Land & Mining Co.'s land by the Silver Dick Mining Co. The lease was worked many years ago, and the sales of concentrates in 1914 showed that the ore bodies remaining could be profitably mined. The Dixon land was operated by the Wyatt Mines Co. and a good production was made by means of hand jigs. A 150-ton concentrating plant was built on the Claude Thornton lease of the Hancock-Connor land, and a 125-ton mill by the Boston Aurora Mining Co. on the Mexico Joplin land. The other leases on the Mexico Joplin land which shipped concentrates in 1914 were Morgan & Co., Shiney Bill, Sunny South, Gussie, and Sweetheart. The largest production of

hand-jigged blende shipped in 1914 came from leases on the Tuckahoe Mining Co.'s land.

The leases on the Sheridan Adams Royalty Co.'s land are equipped with three concentrating plants, and also with hand jigs. The Pocatella mine was the largest contributor to an output, which was about as large as it was in 1913. Other producers in 1914 were the Texas Mining Co. on the Spencer & Lloyd land, the Valentine on Whitworth land (now owned by the H. & F. Mining Co.), the Frisco Mining Co., Missouri Hills Zinc Co., Clark Ward Mining Co., Mary B. Mining Co., and Waneta Pearl Mining Co.

Spring City-Beef Branch district.—The production of galena concentrates in this district decreased about 400 tons in 1914 and the total value of the concentrates sold was $24,681 less than in 1913. The output of lead carbonate was small, as has been usual in recent years. There was a larger output of blende or mixed blende and zinc silicate concentrates than in 1913, but a smaller output of zinc silicate. The total yield of zinc concentrates of all classes was about equal to that of 1913. The value, however, increased $12,149. No new concentrating plants were erected during the year, though quite a number of hand-jig equipments were provided by the small operators. The output of the McCown land was almost entirely derived from the Delta Lead & Zinc Co.'s lease and consisted of galena concentrates and mixed-blende and silicate concentrates averaging 48 to 50 per cent zinc content. An 84-foot shaft was sunk by Arthur Scott and a quantity of blende of a light-green color was recovered.

The producing leases on the J. W. Allen land were the Sunrise, Lone Hickory, and Anna Lee. The last named, which operated a plant built late in 1913, was the largest producer. The St. Paul Mining Co.'s land yielded a good output, and the mining was profitable on account of the rich ore bodies concentrated by means of hand jigs. The lessees who sunk shafts and produced concentrates were Hash & Co., Fairview Mining Co., and the Black Hawk Mining Co. The production at the White Oak mine was small, and operations were suspended at the upper levels while a shaft was sunk to the 100-foot level and drifting started. Other producers in 1914 were the Lu Lu V. Mining Co. on the Zeta Land & Investment Co.'s land, E. L. Fraley on the Armil land, B. D. Mowry on the Weymann land, Georgia Mining Co., T. J. McKinney, lessees of Clark Craycroft on the Leake land, Fay & Bennett on the Witmer land, and J. A. Goodrich on the Peck land.

Springfield district.—A large part of the production from the Springfield district in 1914 represents the output of the Bray Mining & Milling Co. and the Clark Mining Co., located on Pierson Creek, 5 miles southeast of Springfield. The ore deposits are in channels mixed with gumbo and in sheets in the roof. The ore bodies were mined at the 145 to 150 foot levels. The percentage of concentrates in the "dirt" is above the average recovery for the region; moreover, the zinc content of the sphalerite is between 62.5 per cent and 63 per cent and contains very little iron. The galena concentrates recovered are also high grade, averaging about 82 per cent lead. The quantity of sphalerite sold in 1914 was 1,898 tons and that of galena 256 tons, or more than three times as much as the shipments in 1913. The Bray Mining & Milling Co. made its usual large output, and a new mine was developed on the Fallin land by the Clark Mining Co. A

150-foot shaft was sunk and a 100-ton concentrating plant was built, which ran steadily after July. The Gem Mining Co. leased the Parker land and did considerable development, though no output was reported by the owners.

Spurgeon-Seneca district.—The total value in 1914 of the concentrates shipped from this district was $49,953, a decrease of $30,416 compared with 1913. Nearly all the blende concentrates shipped were made by the Bat mine on the Aylor land and the Quaker Maid and Craig & Bushnern, on the Bucklin & Wills land. The other small producers were lessees working on the Granby, Buchanan, and Blue Bird lands. The Bat Mining Co. rebuilt the mill at the Owl mine, increasing its capacity to 150 tons, and opened an ore body of better grade than that previously worked. There were two 100-ton concentrating plants operated on the Bucklin & Wills land, one of which was built in 1915. Six shafts were used to hoist ore from levels varying from 60 to 100 feet deep.

Stotts City district.—There was no work of any importance done in this district, and none of the mines reported any output. The old Gundling mine, now owned by the Lawrence Land & Mining Co., will probably be leased and worked in 1915 by a new company.

Wentworth district.—The value of the production of zinc concentrates in this district was about the same in 1914 as in 1913. The output was composed mainly of blende and less zinc silicate was mined than in 1913. The only large producer was the Jack Possum Mining Co. on the Wentworth Land & Mining Co.'s lease of the Smith land. The Blue Bell 150-ton mill was the only concentrating plant on the lease. The old Mocking Bird or Nancy Jane mine was idle in 1914, but is again under development in 1915. The Gobbler and the Gamecock mines are also being reopened, so that the district production should be larger in 1915 than it has been for the last few years.

Christian and Ozark counties.—The production given in the Missouri table includes the output from the Wetherill district in Ozark County and that of a few mines in Christian County adjoining. The output was entirely zinc carbonate, most of which was derived from the Alice mine of the Empire Zinc Co., near Wetherill. The ore, which is carbonate of zinc carrying limonite, crops out at the surface and is worked down to a depth of 80 feet in a large open pit. The zinc carbonate is cleaned in a log washer having a capacity of about 150 tons per 10-hour shift.

The A. Arnold land in Christian County was leased to F. A. Curnow & Co. and others, and a steam concentrating plant of 60 tons capacity was in operation part of the year. Considerable development has been done by means of tunnels, open cuts, and shallow shafts.

The old Silver Moon mine, near Melva, now owned by the Melva Mining & Milling Co., shipped no concentrates, because an adequate supply of water to run the 100-ton mill built in 1914 could not be obtained. The season was a very dry one in southern Missouri and northern Arkansas and surface or spring water was scarce. A 150-foot shaft was sunk and a 90-foot drift cut. Considerable ore was hoisted, which will be milled in 1915.

Webb City-Carterville-Prosperity district.—This district includes most of the original and typical "sheet-ground" territory, and the low prices paid for both lead and zinc concentrates in 1914 cut off production entirely from some mines; in others no effort was made

to produce a large output. Single shifts were worked and the ground was kept in shape to take advantage of any change in prices. The average recovery of galena and blende concentrates from crude ore mined from "sheet ground" has been between 2.6 and 2.7 per cent for the last five years. It is generally believed that most mines having ore that yields between 2 and 2.5 per cent in concentrates can not be profitably operated when blende concentrates sell for less than $44 or $45 a ton. Many of the "sheet-ground" mines yield 1 ton of galena concentrates to 4 or 5 tons of sphalerite, and the very low prices paid for galena were nearly as disastrous as the shrinkage in price of zinc concentrates. The effect on mining in the district is best shown by the fact that the sales in January, 1914, were about 7,600 tons of sphalerite and about 2,000 tons of galena and that the November sales declined to about 4,600 tons of sphalerite and 1,000 tons of galena. When the Providence mine closed down, the "sheet-ground" mines north of Webb City were in danger of submersion. An arrangement, however, was effected by which the landowners and the mining companies that were benefited, paid for the operation of the large pumps at the Providence mine. The water level has not been lowered since 1913, but the pumping done has prevented the abandonment of many mines. The trend of new operations in "sheet ground" has shifted to the Cartersville-Prosperity portion of the district, and the development there will make a substantial increase in the 1915 output. Only a very small percentage of the district production is derived from "soft ground," and the prominence of the "sheet-ground" mining is indicated by the fact that about 70 per cent of the total production of crude "sheet-ground" ore came from this district. The recovery of galena concentrates in southwestern Missouri from ore mined in "sheet ground" was 15,868 tons, of which this district produced 13,710 tons. The quantity of zinc blende concentrates in southwestern Missouri derived from ore mined in "sheet ground" was 80,228 tons, or 42 per cent of the total zinc blende output of the entire State, and of this large quantity the "sheet ground" mined in the Webb City-Carterville-Prosperity district yielded about 54,063 tons, compared with 66,124 tons in 1913.

The total production of lead concentrates in this district in 1914 was 17,396 tons, or 4,375 tons less than in 1913, and the value decreased $297,398. The production of zinc blende concentrates in 1914 was 64,089 tons, a decrease of 13,380 tons as compared with the output of 1913. The total value of the concentrates sold was $3,242,402 in 1914, $4,298,544 in 1913, and $6,522,781 in 1912. The production from "soft ground" in the district showed a decrease of 691 tons of galena and of 1,319 tons of sphalerite.

Lessees on the Guinn land reported the largest output of zinc concentrates in the district, though the output of both lead and zinc was considerably less than in the two previous years. The capacity of the 12 concentrating plants on the land was in excess of 4,000 tons a day. The leasing companies that produced in 1914 were as follows: Electrical Lead & Zinc Mining Co., Mercantile Metal Milling Co., Ice Plant Mining Co., Rhea Lead & Zinc Co., Mont B. Mining Co. One of the largest producing companies on the Guinn land, the Mercantile, which operated mills Nos. 4 and 5, each of 250 tons capacity, and mill No. 1, of 200 tons capacity, was subleased to Carmean & Squires,

who took over the plants in December. The Electrical mine and 150-ton mill were leased to the Incline Mining Co. during the year. Nearly all the ore milled on the Guinn land was derived from "sheet ground" at levels between 173 and 210 feet deep, and 8 shafts were in use during the year.

The Davey tract of the American Zinc, Lead & Smelting Co. produced the largest output of galena concentrates and the second largest output of blende concentrates in 1914. The Davey mines Nos. 1, 2, 3, and 4 are in the vicinity of Prosperity and are equipped with four double-compartment shafts from 225 to 250 feet deep, and four concentrating plants having a combined daily capacity of over 3,500 tons. Electric power is used at all the plants, and there is a separate plant for the treatment of slimes at Davey No. 3. All the mines were not operated steadily during 1914, nor were the concentrating plants run more than single shift most of the year. The production from the Davey mines was considerably less than in 1913, but in quantity and value was greater than the production of any other single company in southwestern Missouri. The Richland and Hockaday tracts, belonging to the same owners, made a comparatively small output.

The next most prominent producer was the Bertha A. Mining Co., on the Newell Morse Royalty Co.'s land, which had eight shafts in "sheet ground" at 221 feet and milled the dirt at a 1,000-ton plant (24 hours). Considerable new equipment was installed in order to handle the increased quantity of ore sent to the mill after the concentrating plant at the Athletic mine was burned.

The production by lessees of the Center Creek Mining Co., in territory between Webb City and Carterville, was less than in 1913. The Morgan lease, operated by S. Y. Ramage, was not steadily mined and the output was much less than usual. Some dirt from the Sunflower mine on the Smith land and from the Hazlett land was treated at the Ramage mill. Other producers on Center Creek land were the Gray Eagle Mining Co., Ben Franklin Mining Co., Pacific Sludge Co., Pioneer Mining Co., Spotted Dog Mining Co., Central Mining Co., and Wisby & Co. About 18 shafts were in operation, and the 9 concentrating plants had a combined capacity of 1,300 tons. The mines on Center Creek Mining Co.'s land have produced several million dollars' worth of ore, and the land has been continuously worked for many years. The depth of mines varies from 25 to 150 feet, and the production from leases other than the Ramage was larger in 1914 than in 1913.

The production from the lands of the Continental Zinc Co., Ben C. Aylor, Charles Byrd, Bradford Kansas City Mining Co., Carter, Chinn, Daugherty & Davey, Pike Land Co., General Lead & Zinc Co., C. E. Elliott, Rochester Land & Leasing Co., and the Underwriters' Land Co., was less than usual, and there was no special development by lessees in 1914. The mine and mill of the Providence Mining & Milling Co. on the Ashcraft land was in operation up to October, 1914. The property was then closed down but has since been taken over by Steers & Rice. The old Troup mine south of Prosperity, now owned by W. E. Saum, had an increased yield, which came mainly from small lessees who milled their ore at the 150-ton mill on the land.

Many of the large "sheet-ground" mines are directly north of Webb City. A large part of the production for the district came from leases on the property of the Kelly Land Co. and the W. B. S. Land Co. Among the producers on the Kelly land were the White Dog, Osceola, Imperial, and Mineral King mines. Four shafts were utilized to hoist ore from "sheet ground" at levels from 165 to 212 feet deep. The largest producers were the White Dog and the Osceola mines. The combined capacity of the four concentrating plants operated in 1914 was 900 tons per 8-hour shift. Only two tracts of mining land in the district had a larger output of galena and sphalerite concentrates than leases on the W. B. S. Land Co., on which concentrating plants No. 2 and No. 4 were operated by the Carmean & Squires Mining Co. and the Wingfield Mining Co. A sludge plant was also operated by the Leona Mining Co., a sublessee of the Carmean & Squires Mining Co. All of the lessees were mining "sheet ground" at about 200 feet, and the mines were very productive. The Wingfield Co. used three shafts to hoist ore, increased the capacity of the mill, and made many surface improvements.

One of the new properties, which was first operated in 1914, was the Schoolhouse Mining Co. on the Chapman Bros. Mining Co.'s land near Carterville. This company mined "sheet ground" by means of 2 shafts, one 162 feet, the other 165 feet deep. The 400-ton mill was completed and steadily operated after April, 1914. A new shaft is being sunk which will be connected to the mill by a 400-foot tramway.

The 1914 production from the land of the Missouri Zinc Fields Co. was obtained by small lessees working at various depths. The ore was milled at a 75-ton custom mill. The Chamberlain and the Red Top mines were under development and the first named was equipped with the mill formerly used at the Dutchman's Dream mine at Thoms Station. The Laura Alice Mining Co. and the Ben Franklin Mining Co. were merged into the Twin Cities Mining Co., which made a good output in 1914. The Orange Mining Co. erected a 250-ton mill on the Carterville Mining & Smelting Co.'s land, but the mill was not ready for operation until 1915.

The production of both galena and sphalerite from the land of the Connor Investment Co. was larger in 1914 than in 1913, and the development work done by new lessees was the most noteworthy in the district and will result in making the land one of the most productive in the camp. Some of the older mines which were productive were the Sara, Lima, Victor, Ten O'Clock, and Florine. The old Federated mine and 300-ton mill were taken over by the Chicago Mines Co. and operated steadily after September, 1914. The Cumberland Mining & Milling Co. sunk a 200-foot shaft and built a 350-ton mill. Work was started in August and the mill was ready to operate in November. The concentrates shipped, both lead and zinc, were above the average in quality. The Jasper County Mining Co. acquired the old McKinley mine, sunk a new shaft to the "sheet-ground" formation, and had a 350-ton mill under construction. The McDonald Mining Co. was also developing "sheet ground" and erecting a 350-ton concentrating plant. The Zinc Corporation late in the year commenced preparations to drain the Burgner, Edgar, and other lands in the vicinity of Prosperity. The year 1914 was

not a prosperous one for the district, but the work accomplished and in prospect should result in an output nearly equal to that for 1912

Zincite-Smithfield district.—The mines in this district include those in the territory south of Zincite along the western border line between Missouri and Kansas to the north of Smithfield.

The total yield of sphalerite in 1914 was 3,921 tons, valued at $147,048, or only about one-half that of 1913. Although the northern part of the district was active, no large producing properties similar to the Yellow Jacket and the Yellow Pup were developed. More than 50 per cent of the entire output of the district was shipped by the Yellow Pup Mining Co. on the Lafferty land. The Locke mine on this land was also a small shipper in 1914. The production of the Aberdeen Mining Co. was less than usual and its operation was spasmodic. The second largest output in the district was that of the Minor Graham Lead & Zinc Co. on the Parkinson, Graves & Harper land. A new 100-ton mill was built by the Clara C. Mining Co. on the Llewellyn land, which was not ready for operation until January, 1915. Other lessees on the land shipped considerable lead and zinc concentrates. A lease on the Robinson land was under development by the Seven Mining Co. and a mill was in course of erection. The Geronimo Lead & Zinc Mining Co. opened a good mine on the old Fisher land and the 200-ton mill was finished in January. Among the producing mines near Zincite were lessees of the Belville Land & Mining Co., and of Geneva Mining & Leasing Co., Chas. W. Edwards, L. E. Holden & Co., and also the Abaline Mining Co. on the Davison & Wright land, the Sophia Mining Co. on the Staples land, and E. F. Cameron, Gray Eagle Mining Co., and F. V. Wasserman on the Llewellyn land.

CENTRAL AND SOUTHEASTERN MISSOURI

The ore deposits of central and southeastern Missouri reach in a more or less connected belt from the region of Benton, Pettis, Morgan, Moniteau, Cole, and Miller counties on the northwest to the northern and eastern flanks of the St. Francis Mountains on the southeast. It is also true that there are scattered areas where more or less mining has been done all the way between the northwest end of this belt and the Joplin region, so that strictly speaking the lead and zinc deposits of Missouri practically form a zone around the northern half of the Ozark dome.

The deposits in the counties named above, corresponding to the central Missouri region, are of the general type of those in the Joplin region, in that the ores consist of galena and sphalerite, or the oxidized derivatives of those minerals, and occur in association with solution breccias and sink-hole shale patches, the ore being found in the Cambrian and Ordovician dolomites and included cherts and occasionally in the Pennsylvanian shale. The occurrence of ore in crevices or thin vertical sheets is very common, but practically all the production of ore has been obtained from sink-hole breccias or "circles," a form of deposit noted as also important in the southwestern Missouri area.

The southeastern part of the belt, in the vicinity of the St. Francis Mountains, forms the disseminated lead region of southeastern Mis-

souri. The earlier workings were shallow, and even yet considerable shallow lead is raised, generally in connection with the mining of barytes, or "tiff," as it is locally known. The mines in the disseminated lead region range from 100 feet to about 550 feet in depth, depending on the depth from the surface to the basal portion of the Bonneterre limestone.

The ore deposits now worked are almost wholly in the lower part of the Bonneterre limestone, where they occur in disseminated form over large areas, relatively richer in the vicinity of the intersecting crevices and joints. The crevices show little if any displacement, and there are no breccias of consequence. The copper, nickel, and cobalt in Madison County occur with galena and marcasite in blanket formation in the carbonaceous beds of parting at the contact of the Bonneterre limestone with the Lamotte sandstone below, and in the vicinity of the intersection of this contact with the sloping surface of the pre-Cambrian rocks. Both the Bonneterre and the Lamotte formations are of Cambrian age.

Prospecting is done by means of the diamond drill, and extensive campaigns of drilling have been prosecuted in the vicinity of all the important producing tracts.

The diamond drill is also used in mining as an aid in following the ore. Cores are taken from the heading in various directions, straight ahead, at angles upward, downward, or to the side, and from these cores the direction to drive the heading is determined.

The ore in the southeastern Missouri region is almost wholly lead, although a considerable zinc deposit occurs at Valle mines, some 6 miles north of the Bonneterre district. A certain percentage of zinc is also found in the disseminated lead ore, the ore from one shaft being reported to run occasionally as high as 2 per cent of zinc for a week at a time. The zinc occurs more plentifully in the Leadwood-Flat River districts, and may lie near the contact of the Bonneterre limestone with the Lamotte sandstone or some distance above it. In the lead concentrates zinc ranges from 1 to 5 per cent or more. In the maximum proportions mentioned the zinc makes trouble in lead smelting, and for this reason some of the concentrating plants remove the zinc as a table middling. An interesting feature of the zinc middlings is that they carry a disproportionately large part of the silver content of the ore, the silver being apparently associated with the zinc rather than with the lead.

Copper, nickel, and cobalt also occur in the ore, in greater quantity in the vicinty of Fredericktown, and in small quantity, irregularly, in nearly all the deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district, and in some instances has been a source of income.

The lead deposits of southeastern Missouri have been known for over 200 years. The first discovery of lead was by Pericaut, one of Le Sueur's party, which ascended the Mississippi in the year 1700.[1] About 1720 Renault and La Motte sent out exploring parties in search of precious metals, and the lead deposits at Mine La Motte in Madison County were discovered and worked to a small extent.

[1] Winslow, Arthur, Lead and zinc deposits of Missouri: Missouri Geol. Survey, vol. 6, pp. 267–302, 1894.

In 1724 to 1726 lead ores were discovered and worked near Potosi in Washington County. During the last 60 years of the eighteenth century only slight attempts at mining were made, though other lead deposits were discovered in St. Francois and Washington counties. The erection of the first reverberatory furnace and a shot tower by Austin about the year 1799 greatly stimulated the mining of lead ores. Austin also sank the first shaft, which is said to have been 80 feet deep. Between 1,800 and 1,820, mines were discovered near Bonne Terre, Cadet, Richmond, and other places, so that in 1819 there were 19 mines in operation and the estimated output of lead was about 1,500 tons a year. In 1820 lead was found in Cole County, in 1824 in Jefferson County. The well-known Valle mines in St. Francois County were also discovered in 1824 by Joseph Shultz and the Valle ore deposits were actively worked in 1915, so that the property has a record of nearly 100 years as a producing mine. From 1830 to 1850 the output of lead increased rapidly. Lead mines were developed in Franklin County in 1830, in Benton County in 1848, in Morgan County in 1839, in Moniteau County in 1841, and in Cooper and Crawford counties in 1844; the older mines in the other counties were worked, and other mines were opened. Between 1850 and 1860 galena was discovered and mined in Maries, Miller, Osage, Pulaski, Phelps, and Crawford counties, but the production of lead from these counties has been comparatively small when compared with the output of St. Francois, Madison, Washington, and Jefferson counties. The St. Joseph Lead Co. was organized in 1864 at the present town of Bonne Terre, and active operations were begun in 1865. The first year's output is estimated to have been 240 tons, which was hardly more than a day's yield of the company in 1914. Diamond drilling was first introduced into the lead region by this company in 1869, and it resulted in the discovery of the disseminated ore deposits, which now yield more than 99 per cent of all the lead from southeastern Missouri. In 1869 a zinc smelter was established at Carondelet, and the Valle mine became a large shipper of zinc carbonate ore. In 1892 the output of the St. Joseph Lead Co. was more than 21,000 tons of galena, and the Mine La Motte, Desloge, and Doe Run mines were also in operation. In the central Missouri region the mining was intermittent and the production small. The lead ore production of St. Francois County up to 1869 has been estimated by Winslow at 59,526 tons, valued at $1,984,900, and the output of Washington County during the same period at 124,930 tons, valued at $5,082,700. This production was obtained from shallow workings above the water level. Since 1869 the production from Washington County has decreased,[1] and nearly all the output has continued to be obtained from surface work and shallow shafts and tunnels. In the disseminated ore district the production since 1869 increased rapidly and is estimated by Buckley to have amounted to 1,202,607 tons of lead concentrates, valued at $59,869,354 for the period between 1869 and 1906, inclusive. The mine production of southeastern and central Missouri has been reported to the United States Geological Survey since 1907, and the following table shows the

[1] Buckley, E. R., Geology of the disseminated lead deposits of St. Francois and Washington counties: Missouri Bur. Geology and Mining, vol. 9, pt. 1, pp. 1-3, 1908.

output of lead and zinc concentrates for the years 1907 to 1914, inclusive:

Mine production of lead and zinc concentrates of southeastern and central Missouri, 1907–1914, inclusive, in short tons.

Year.	Lead concentrates—galena.		Zinc concentrates.			
			Sphalerite.		Carbonate and silicate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	156,663	$7,910,398	100	$3,500	1,095	$15,330
1908	183,095	6,906,116	42	1,050	1,369	20,436
1909	210,620	8,823,297	41	938	1,284	17,334
1910	210,890	9,360,309	.....	.....	929	19,000
1911	219,145	10,293,400	113	3,990	510	11,576
1912	218,803	9,849,854	40	1,292	1,051	21,020
1913	219,511	9,580,893	33	574	639	13,491
1914	249,165	9,710,125	40	700	497	11,282
Total	1,667,892	72,434,392	409	12,044	7,374	129,469

A comparison of the estimates for the period of years to 1906 given by Winslow and by Buckley for Washington and St. Francois counties (which have supplied a very large per cent of the galena ores from southeastern and central Missouri) with the figures in the table above apparently indicates a production of galena concentrates during the last eight years equal to if not more than the entire output of southeastern and central Missouri prior to 1907.

The lead ore of southeastern Missouri carries a small proportion of silver, the average being a very little over 1 troy ounce to the ton of lead concentrates. The resulting pig lead likewise carries silver, together with a little copper, nickel, cobalt, and traces of antimony and arsenic, and is sometimes commercially known as "Missouri chemical" lead in contradistinction to "Missouri soft" lead from the Joplin region. An average of about 15 per cent of the total lead concentrates from southeastern Missouri is desilverized. The silver so recovered does not pay for the refining charges, but the desilverized lead commands a slightly higher price, making up the difference. As the silver content of the concentrates is so small, it is disregarded in their sale, and therefore the smelter reports are relied upon for the silver production. As already explained, the quantity of silver produced during any year bears no direct ratio to the quantity of silver-bearing lead concentrates smelted during that year, for the reason that the silver bullion is stored and refined in batches at convenient times.

The silver output of Missouri in 1914 was derived almost entirely from lead concentrates, the only other source of production being a small quantity of sorted copper ore shipped from the Swansea mine to Omaha for smelting.

The silver production of southeastern Missouri was 61,168 fine ounces in 1914, as compared with 35,620 fine ounces in 1913, 35,438 fine ounces in 1912, 49,867 fine ounces in 1911, 33,096 fine ounces in 1910, 14,188 fine ounces in 1909, and 49,131 fine ounces in 1908. The silver production of 1914 was recovered from 61,995 tons of lead concentrates and from copper ore that averaged 0.77 ounce per ton.

The crude lead ore mined in 1914 amounted to 4,718,300 short tons, against 4,250,800 short tons in 1913, 4,064,366 tons in 1912, and 3,974,712 tons in 1911. The crude ore in 1914 yielded 5.27 per cent of lead concentrates, which averaged 67.6 per cent of lead. The average value per ton of the lead concentrates in 1914 was $38.96, as compared with $43.63 in 1913, and the concentrates were slightly higher in lead content than in 1913. The output of galena concentrates was 249,165 tons, valued at $9,710,125, in 1914, against 219,511 tons, valued at $9,580,893, in 1913. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are arbitrary to a certain extent. The galena concentrates produced in the southwestern Missouri region containing a higher lead content are mainly sold on bids from various purchasers, and the prices for those lead concentrates are not comparable with prices given for concentrates of the disseminated lead district.

The production of sphalerite from central Missouri in 1914 amounted to only 40 tons, valued at $700, which was slightly more than in 1913. The production of zinc carbonate from southeastern Missouri in 1914 amounted to 497 tons, against 639 tons in 1913.

The output of lead recovered in mining shallow diggings in Washington and Jefferson counties was less than in 1913, and the yield of lead and zinc from central Missouri was small.

The production of galena concentrates from the disseminated lead district was the largest ever recorded, exceeding that of 1913 by about 30,000 tons. A much larger output could have been made, but the continued low prices caused many of the large companies to reduce their output during the last quarter of 1914. Fewer shafts were used to hoist ore for the milling plants, though the ore treated in 1914 exceeded that of 1913 by more than 450,000 tons. Expenses were reduced by shutting down outlying shafts, and a larger recovery of concentrates was made possible by more efficient milling methods, including the flotation process. Labor conditions were generally satisfactory and there were no strikes of any magnitude.

REVIEW BY COUNTIES.

Cole County.—Very little ore was mined at the Black Jack mine in 1914. The zinc blende is mixed with barytes and operations were suspended until experiments with the new Greenstreet separating process were completed. Galena ore mined by means of shallow shafts was shipped by Reuben Cole, of Russellville.

Benton County.—A small quantity of sphalerite and galena concentrates was produced by the United Zinc & Barytes Co. from ore mined at the Tahoma mine and experimentally treated to obtain a method of economically separating the zinc from the barytes.

Washington County.—Several companies owning large tracts of land in Washington County, such as the Washington Land & Mining Co., the Southeast Missouri Lead Co., the Parole Mining & Mercantile Co. (successors to the Renault Lead Co.), work their property on a royalty basis. The ore which occurs at shallow depths and in association with barytes is mined in a small way and at odd times by the barytes miners. This ore is all hand picked and cleaned, there being no concentrating plants. There are numerous other shallow lead and barytes diggings scattered over Washington County which are worked by small operators and farmers, who sell their product to the country

merchants and to ore buyers. Much of this ore was purchased by James Long, and Bugg Eversole & Towle, of Potosi, and Buren Duckworth, of St. Claire.

Jefferson County.—The Valle Mining Co., with offices in Jefferson County, also operates on a subleasing or royalty system a large tract of land which lies partly in St. Francois County. The ores are galena and zinc carbonate and are found at depths ranging down to 225 feet, depending on the topography. The yield of concentrates in 1914 was less than in 1913, but the quantity of galena sold increased. Work on the new shaft at the Garatee tract was discontinued at the depth of 40 feet and another shaft was sunk on the edge of the main zinc belt to the depth of 200 feet and drifts were cut at various levels. The drift on the 160-foot level was driven 450 feet to connect it with an old drift from shaft No. 4.

On the tract there is a Scotch hearth lead furnace which has not been operated for several years, and a kiln in which the zinc carbonate ore is calcined before shipment.

Ste. Genevieve County.—The only copper ore from Missouri sold or treated in 1914 was a small quantity shipped by the Swansea copper mines in Ste. Genevieve County. The ore, which is oxidized, contains, in addition to the copper, a small quantity of silver.

St. Francois County.—The St. Joseph Lead Co. (a description of whose mines, surface, and smelter equipment is given in the Central States report for 1912) reported the recovery of a larger quantity of galena concentrates and the lead content of the concentrates was about 4 per per cent higher in 1914 than in 1913. Flotation plants were installed in connection with both concentrating plants, which have a combined capacity of 3,600 tons a day. Seven shafts were in operation part of the year, but during the latter part the outlying shafts were shut down and the ore was hoisted from No. 1 and the Leadwood shaft.

The Doe Run Lead Co. operated 5 shafts for 9½ months and 4 shafts for the remainder of the year in the Flat River district. The mill of this company of 4,000-ton capacity is one of the best equipped in the district. The building is of steel construction throughout. The mill machinery is operated by alternating current 440-volt motors, which receive their current from the central gas-electric power station at River mines. All shaft equipment, such as hoists, compressors, underground pumps, are motor driven. Four 800-horsepower Snow twin tandem gas engines, direct connected, each with a 600-kilowatt generator, furnish power to all shafts and mill machinery. The gas-producer plant has four 800-horsepower Loomis-Pettibone producers and one 1,000-horsepower Westinghouse producer.

The underground haulage at shafts Nos. 1 and 4 is done by air locomotives. At all other shafts mules are used. No copper concentrates were produced in 1914.

The Desloge Consolidated Lead Co. in 1914 operated 3 shafts, 2 of which are each 300 feet and the other is 500 feet in depth. Two of the shafts are near the town of Desloge, but No. 4 shaft is near Leadwood. The concentrating plant is equipped with 2 Hancock jigs, 30 Wilfley tables, 10 Frue vanners, and appropriate rolls and Chile mills. The capacity of the concentrating plant is 1,500 to 1,700 tons per day of 24 hours. A 780-kilowatt Westinghouse steam turbine was added to the equipment in 1914. The smelter near the concentrating plant is equipped with 4 Flintshire-Tarnowitz reverberatory furnaces, only 2

of which have been operated in recent years, the "gray" slag being sold to other smelters.

The production of galena concentrates in 1914 was not quite so large as in 1913.

The St. Louis Smelting & Refining Co. has its mines in the vicinity of the village of St. Francois, about 1 mile north of Flat River. Three shafts, ranging from 208 to 565 feet in depth, were in operation in 1913. The bottom of the ore was reached in shaft No. 6 at 540 feet and the Lamotte sandstone at 560 feet. The concentrating plant is modern, having a capacity of 2,200 tons per day of 24 hours, and is equipped with Hancock jigs, Overstrom classifiers and tables, Frue vanners, and slime and settling tanks. A central steam power plant drives air compressors and electric generators. The mill, hoists, and pumps are operated by electricity, as well as the underground haulage and the trains for handling the ore from the shafts to the mill. This company also operates a lead smelter and refinery at Collinsville, and the lead concentrates produced by the mines, and also those derived from crude ore purchased from the St. Francois Lead Co. were smelted at that plant.

The Mine La Motte property in Madison County was operated from January 1 to May 31, 1914, by the St. Louis Smelting & Refining Co., which also treated the crude ore produced by the St. Francois Lead Co.

The Federal Lead Co. operated 3 shafts during 1914, mining and milling 1,211,000 tons of crude ore. The capacity of the mill is the same as during 1913, namely, 4,600 tons per day; the mill is equipped with 12 Hancock jigs, 72 tables, and 30 vanners, arranged in three units of three sections each. There are also regrinding rolls, elevators, Esperanza-Federal drag classifiers, and a supplementary slime treatment. During 1914 in addition to the regular lead shipments there was a small tonnage of copper concentrates recovered as a by-product by means of a roasting magnetic separating plant. During the year additions were made to the central power plant and certain auxiliary plants were shut down. Three 500-horsepower boilers were added to the central power plant together with an Allis-Chalmers 800-kilowatt horizontal turbine and a compound steam driven compressor. With this power electric current was supplied to No. 7 shaft, where 3 electrically driven, geared, vertical, triplex plunger pumps of 1,400 gallons a minute were installed for mine drainage. The mines and plants are situated in the vicinity of Flat River, St. Francois County.

The Federal Lead Co. operated the old Phoenix and also the Fleming property under lease during the early part of 1914, mining and milling therefrom some 400 tons a day, but lower lead prices later in the year caused operations at these properties to be temporarily suspended.

The St. Francois Lead Co., which purchased the Alma mine in 1912, operated 1 shaft which was 400 feet deep. About $25,000 was expended on new equipment in 1914. No concentrating plant was erected, as the crude ore is shipped to the St. Louis Smelting & Refining Co.'s plant at St. Francois. The lead content of the crude ore, which is sold on an assay basis, is said to average about 6.8 per cent.

Madison County.—The Mine La Motte was operated by the St. Louis Smelting & Refining Co. until May 31, 1914, and the remainder of the year by the Mine La Motte Co. Four shafts and several prospects were operated during 1914 on a tract which was first mined in 1720. The shallow deposits which were first worked were followed

down to a depth of 100 to 125 feet, from which level the ore has been coming, which for 50 years has supplied the mill and smelter. The mill, which is practically new, has a capacity of 500 tons per day of 24 hours, and is equipped with Hancock and Harz jigs and tables. The attempt was made some years ago to smelt the copper and nickel-cobalt sulphides, which in certain parts of the mines occur plentifully with the lead and are separated in concentration. Of late years these ores have been avoided and attention in mining has been limited to the lead ores.

OKLAHOMA.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Oklahoma in 1914 is shown in the following table:

Production of lead and zinc in Oklahoma in 1914, by districts, in short tons.

District.	Ore.					
	Lead concentrates (galena).		Zinc concentrates.			
			Sphalerite.		Carbonate and silicate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ottawa County:						
Miami	9,401	$443,493	28,219	$921,647	.....	.....
Peoria	.....	.....	.....	.....	6	$100
Quapaw	1	50	146	5,091	2	40
State total:						
1914	9,402	443,543	28,365	926,738	8	140
1913	7,810	403,097	24,103	766,392	67	1,340
1912	4,257	231,678	12,129	494,379	92	2,550
1911	3,189	171,357	10,661	330,943	512	11,216
1910	[a] 3,638	188,063	13,976	447,043	280	5,572
1909	4,306	223,377	16,584	568,614	453	10,627
1908	2,236	118,333	10,038	249,991	280	6,625
1907	667	45,046	3,076	119,008	650	15,667

District.	Metal content.[b]			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Ottawa County:				
Miami	7,555	$589,290	13,915	$1,419,330
Peoria	.....	.....	2	204
Quapaw	1	78	75	7,650
State total:				
1914	7,556	589,368	13,992	1,427,184
1913	6,228	548,064	11,664	1,306,368
1912	3,388	304,920	5,769	796,122
1911	2,501	225,090	5,150	587,100
1910	2,888	254,144	6,394	690,552
1909	3,427	294,722	7,806	843,048
1908	1,781	149,604	4,529	425,726
1907	532	56,392	1,657	195,526

[a] Includes a few tons of lead carbonate.

[b] In calculating the metal content of the ores for assays, allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal, it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the metal is calculated from the average daily quotations at New York and St. Louis.

The following table gives the crude lead and zinc ore output for the whole State of Oklahoma, but it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and Quapaw districts, inasmuch as the character of the ground operated in these districts differs so radically that general calculations for the State would be valueless:

Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1913 and 1914.

	1913	1914
Total crude ore milled in Oklahoma.....short tons..	581,100	793,920
Miami district:		
Total concentrates in crude ore—		
Lead.....per cent..	1.5	1.24
Zinc.....do....	4.4	3.84
Metal content of crude ore—		
Lead.....do....	1.2	1.00
Zinc.....do....	2.4	2.03
Average lead content of galena concentrates.....do....	79.8	80.0
Average zinc content of sphalerite concentrates.....do....	53.6	54.8
Average value per ton—		
Galena concentrates.....	$52.91	$47.19
Sphalerite concentrates.....	$31.50	$32.66
Quapaw district:		
Total concentrates in crude ore—		
Lead.....per cent..	0.2	.....
Zinc.....do....	1.9	3.82
Metal content of crude ore—		
Lead.....do....	0.13	.....
Zinc.....do....	1.1	2.14
Average lead content of galena concentrates.....do....	78.4	79.0
Average zinc content of sphalerite concentrates.....do....	55.8	56.2
Average value per ton—		
Lead concentrates.....	$51.55	$50.00
Sphalerite concentrates.....	$38.03	$34.87

Oklahoma was the only one of the Central States which showed a larger output of both lead and zinc in 1914 than in 1913. The value of the silver, lead, and zinc produced at mines in Oklahoma in the year 1914, notwithstanding lower prices for all metals, was $2,019,973, compared with $1,855,218 in 1913. The metal content of lead concentrates increased from 6,228 tons, valued at $548,064, in 1913 to 7,556 tons, valued at $589,368, in 1914, and the recoverable zinc increased from 11,664 tons, valued at $1,306,368, to 13,992 tons, valued at $1,427,184.

The increased yield of lead and zinc in 1914 was entirely due to operations in the Miami field, as the mines in the Quapaw and Peoria districts reported a much smaller output and there were no shipments from the Arbuckle Mountain region in Murray County. The relatively small output of zinc silicate came entirely from the Peoria and Quapaw mines. Most of the mines in the Quapaw district were idle the greater part of 1914, and the value of their product was less than one-eighth that of 1913.

In 1914 the lead concentrates produced in the Oklahoma districts were of slightly higher grade than those shipped in 1913. The average metal content of the sphalerite concentrates from Miami ore increased from 51.8 per cent in 1912 to 53.6 per cent in 1913, to 54.8 per cent in 1914, and was only 1.4 per cent less than the average metal content of the sphalerite from the Quapaw district.

The lead concentrates from Oklahoma sold in 1914 were 1,592 tons more in quantity and $40,446 greater in value than in 1913. Miami

district produced more lead than any district in the Joplin region, with the exception of Webb City-Carterville, and its yield was equal to about one-fourth of the production of the Joplin region. The Oklahoma shipments of sphalerite in 1914 amounted to 28,365 tons, valued at $926,738. This was an increase of more than 4,200 tons in quantity and of $160,346 in value.

The shipments of zinc carbonate and silicate decreased from 67 tons in 1913 to 8 tons in 1914. The Miami district yielded over 99 per cent of the sphalerite concentrates and practically all the galena concentrates sold in Oklahoma in 1914. In addition to the production of lead and zinc, 190 tons of silver ore were shipped from McClain County, which yielded 6,187 fine ounces of silver, valued at $3,421.

The lead and zinc deposits of northeastern Oklahoma, so far as known, are confined to the limits of Ottawa County and form the southwestern extension of the Joplin region. There are three camps, Peoria, Quapaw, and Miami, in this county, in which extensive mining has been done, and a fourth, the Sycamore Creek district, along the Seneca fault block from 2 to 3 miles southwest of Seneca, Mo., in which considerable prospecting has been done and some ore mined.

The lead and zinc deposits in southern Oklahoma are near Ravia at the southeast end of the Arbuckle Mountains and near Davis, Murray County, at the northwest end of the same range.

Peoria is the oldest mining camp in the State, and galena and blende were principally mined in the beginning, but in recent years the small output has been mostly of carbonate and silicate ores.

The mines at Peoria were opened in 1891 by the Peoria Mining Co., and about $1,000 worth of ore was sold in 1891 and 1892. In 1893 and 1894 about 1,363 tons of galena were hauled to Joplin and sold to the Joplin White Lead Works,[1] and 56 tons of sphalerite and 332 tons of zinc silicate were hauled to Baxter Springs. Some sales of zinc and lead concentrates were recorded in the Joplin Herald mining news items for the period 1901 to 1906. Absence of railway transportation has retarded the development of the camp, and mining operations have always been intermittent. In 1907 a small mill was erected by the Chicago Syndicate Mining Co., and ore bodies were mined at the 140 and 160 foot levels on its property. The mill has never been run steadily, and very little prospecting for ore at deep levels has been done. It is impossible to give more than an estimate of the total production of the camp. It has not been large and probably will not increase to any extent until transportation facilities are provided. The estimated total production for the period 1907 to 1914 has been as follows:

Estimated production of lead and zinc concentrates in Peoria district, Oklahoma, in short tons.

	Quantity.	Value.
Galena	41	$2,405
Lead carbonate	6	317
Sphalerite	44	1,397
Zinc silicate	1,620	41,385

[1] Snider, L. C., Preliminary report on the lead and zinc deposits of Oklahoma: Oklahoma Geol. Survey Bull. 9. 1912.

The Quapaw district[a] mines extend from 1 to 4 miles east of Quapaw and from 5 to 7 miles south of Baxter Springs, Kans. The first shaft in the district was sunk in 1904 on the Abrams land.

Some shallow silicate and galena has been mined, but the chief production is blende and galena ores from sheet ground at a depth varying from 80 to 150 feet. This sheet is known as a blanket breccia, because the ore occurs in crevices and in the cement of the chert breccia and not between the chert sheets, as in the typical sheet ground of the Webb City (Mo.) district. The ore is associated with pink spar and jasperoid, but aside from the pink spar otherwise is similar to the sheet-ground ores.

The production of zinc concentrates increased yearly, until 1907, when the largest recorded output of the district was made. The mines also produced considerable galena in the period between 1905 and 1911, the largest yield being that recorded in 1906.

In 1907 there were 27 concentrating plants, with a daily capacity of 3,300 tons, and there were also 7 mines using hand jigs. Many of the mills were erected before sufficient ore bodies were developed and never were operated at a profit. The production has steadily declined since 1910, and many of the concentrating plants have been removed. Production reached the lowest point in 1914 since the district was opened. As many of the properties are equipped with good milling plants, the advancing ore prices will probably cause the reopening of the mines, and the Quapaw district will contribute a substantial part of the lead and zinc yield of Oklahoma in 1915.

The following table gives the production of lead and zinc concentrates in the Quapaw district from the year they were first operated (1904) to the end of 1914:

Production of lead and zinc concentrates in the Quapaw district, Oklahoma, 1904–1914, inclusive, in short tons.

Year.	Lead concentrates (galena).		Zinc concentrates.			
			Sphalerite.		Zinc silicate and carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	150	$8,250	633	$18,990	.....	.....
1905	566	34,450	2,670	103,480	.....	.....
1906	669	51,299	3,242	124,528	.....	.....
1907	[b] 647	43,644	[b] 3,062	118,440	97	$1,631
1908	504	26,076	3,539	109,779	19	300
1909	244	12,545	5,015	207,585	38	586
1910	270	13,727	3,921	152,166	.....	.....
1911	329	18,202	2,245	82,571	6	85
1912	1	50	1,621	78,404	2	50
1913	97	5,000	1,097	41,037	.....	.....
1914	1	50	146	5,091	2	40
Total	3,478	213,293	27,191	1,042,071	164	2,692

[a] Siebenthal, C. E., Mineral resources of northeastern Oklahoma: U. S. Geol. Survey Bull. 340. 1907.
[b] A small production from one mine in Miami district is included.

The first mines discovered and worked in the Miami district were those near Hattenville, now called Commerce, about 4 miles north of Miami. The first drilling was done by Robinson & Coleman (now Commerce Mining & Royalty Co.) in 1905. The first shaft was sunk in 1907, and a concentrating plant which had a capacity of 100 tons was built by the New State Mining Co. This mill was completed and in operation in August, 1907, but was not operated steadily until 1908. The ore body on the Old Chief mine was also developed in 1907, and a mill was completed late in the year. The Emma Gordon Mining Co. also sunk two shafts and erected a 250-ton plant, which was started early in 1908 and made the largest production in the district for that year. All of these mines have been constant producers since they were opened. Shafts were sunk in 1907 or 1908 at the Old Chief, Buckeye, King Jack, Turkey Fat, Lucky Strike, Index, Tom Lawson, and other mines, and they were equipped with milling plants. A standard-gage railway was also constructed between Hattenville and Miami where connection was made with the St. Louis & San Francisco Railroad. Most of the output from the district has been derived from mines on leases of the Miami Royalty Co. (now Commerce Mining & Royalty Co.) and the Emma Gordon Mining Co. There were some productive mines, among which were the Golden Hen, Crescent, Willow Branch, and Consolidated, on the Baxter Royalty Co.'s lease, which were later taken over by the Miami Royalty Co. In 1911 and 1912 the territory was developed northeast and northwest of Commerce, and the mines of the Carson Mining Co., Prairie Mining Co., Thirty Acre Mining Co., Chapman & Lennan, and Grey Top Mining Co., were opened and equipped with concentrating plants.

The year 1913 was one of very active development, and drilling operations extended from Commerce northwest and also northeast along Tar Creek as far as the Kansas State line. The McConnell Lead & Zinc Co. sunk two shafts and erected a mill. The Blue Bird mine was also developed. The Grey Top mine marked the northwest limit of the producing area of the district. To the southwest of Commerce and about 1½ miles northwest of Miami new territory was developed by McConnell & Barnes. The year 1914 showed a continuation of the drilling in both the northeastern and the southwestern areas.

At Miami the ores were first discovered in a brecciated sandstone of Chester (late Mississippian) age. At the point first mined this sandstone lies at a depth of 90 feet from the surface and just below the Cherokee shale, of Pennsylvanian age. The ore body first discovered proved to be part of a long narrow run, which bears north-northwest and extends from the Cactus mine on the south to the Grey Top mine on the north, a distance of 1½ miles. Throughout this distance the ore body is in the sandstone breccia, with shale overlying, though at places in the run stopes have been taken up in the underlying chert breccia. The width of the run varies from 75 to 150 feet, and the height from 8 to 13 feet, ranging up to 25 feet where the lower stopes have been taken up. From the south end of this run the ore was found to increase in depth to the north until at the north shaft of the Church-Mabon mine, about two-thirds of the dis-

tance to the north end of the run, the depth to the bottom of the ore was found at 240 feet. From this point to the north end of the run the depth to the ore becomes less. At the Grey Top mine the top of the ore is found at 160 feet in chert, some distance below the sandstone. Four other runs parallel to the main run are found to the southwest of it, but they are much shorter, the Midas-Golden Hen run with a length of something over half a mile being the longest. Practically throughout the south half of the long run deeper runs have been found below the upper run and are being worked in the Boone limestone.

A northeast run branches off from the long run about one-third of the distance from the north end and extends, as at present developed, about three-quarters of a mile. This run occurs along the highly inclined contact of the sandstone of Chester age and the Boone limestones and about midway of its course reaches from 150 feet to a depth of 285 feet. A deeper run is worked beneath the latter at a depth of 320 feet, but this is entirely in the Boone limestone.

A mile north of the end of this run is another northeast run nearly parallel but not exactly in line with the foregoing. A mile farther to the northeast several shafts have been opened in ore, but the openings are not large enough as yet to show the trend of the run.

At the Cornfield mine, a short distance southwest of the McConnell Lead & Zinc Co.'s property, shallow ore was mined at a depth of 92 to 110 feet, and drilling disclosed a lower run at 180 to 200 feet. Drilling on secs. 16, 17, 20, and 21, in T. 29, R. 23, is said to show extensive bodies of ore below 250 feet in the Grand Falls chert member of the Boone limestone.

The ore in the Horse Shoe Lake camp, 1½ miles northwest of Miami, has been mined from levels between 75 and 100 feet deep, and in 1914 one shaft was in ore at the 222-foot level. The trend of the ore body so far developed appears to be northeast, but the development work has not definitely established the fact that the run extends northeast to Commerce.

The ores are galena and sphalerite in the proportion of about 1 of the former to 3 of the latter, no oxidized ores having yet been found.

The sandstone in the older and shallower mines was impregnated with a heavy oil, which, evaporating to asphalt, caused much trouble in saving the concentrates, by balling up the ores on the jig beds and tending to float off the finer particles. As mining developments in the upper level worked away from the territory first opened in the southern part of the field and as the deeper level was opened in the original district, it was found that the oil became much less plentiful. It now seldom occurs in quantity sufficient to make any trouble in milling or to affect the grade of the concentrates.

The total production of the district to the end of 1914, with the exception of the small output made by the New State mine in 1907, is given in the accompanying table. The total value of all concentrates sold to the end of the year 1914 has been about $4,800,000, which is four times the value of the output from the Quapaw district.

The production of the Miami district is shown in the following table:

Production of lead and zinc concentrates in the Miami district, Oklahoma, 1908–1914, inclusive, in short tons.[a]

	Lead concentrates (galena).		Zinc concentrates (sphalerite).		Total value of concentrates.
	Quantity.	Value.	Quantity.	Value.	
1908	1,730	$92,177	6,475	$139,595	$231,772
1909	4,056	210,586	11,509	361,029	571,615
1910	3,364	174,134	10,055	294,877	469,011
1911	2,848	152,527	8,391	247,530	400,057
1912	4,256	231,628	10,258	405,975	637,603
1913	7,710	397,927	23,018	725,163	1,123,090
1914	9,401	443,493	28,219	921,647	1,365,140
Total	33,365	1,702,472	97,925	3,095,816	4,798,288

[a] A small output made by the New State Mining Co. in 1907 is included in the output of the Quapaw district.

The producing mines in the southern part of Oklahoma are located 8 miles southwest of Davis in Murray County, near the northwest end of the Arbuckle Mountains. The ore deposits are found in the dolomitic Arbuckle limestone, generally in clay-filled solution channels. The zinc ore occurs as a carbonate from the surface to a depth of 5 to 8 feet. Below this level the zinc is in the form of the sulphide.[1]

Nearly all the ore has been taken from shallow workings and none of the mining properties have been large producers. The first ores were mined in 1909, and small shipments were made in that year and in 1910, 1911, and 1912. No output has been reported by any of the mining companies for the last two years and the total recorded production of the district has been 558 tons of zinc carbonate, valued at $9,660, and 275 tons of sphalerite, valued at $10,842.

The total production of lead and zinc concentrates in Oklahoma can not be exactly determined, owing to the incomplete data for the Peoria district. The following table, however, gives the approximate shipments of the State for the period 1891 to 1914:

Production of lead and zinc concentrates in Oklahoma, 1891–1914, in short tons.

District.	Lead concentrates (mainly galena).		Zinc concentrates.			
			Sphalerite.		Zinc silicate and carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Peoria	1,683	$75,325	56	$616	2,071	$46,241
Quapaw	3,478	213,293	21,191	1,042,071	164	2,692
Miami	33,365	1,702,472	97,925	3,095,816	.....	.....
Davis	.....	.....	275	10,842	558	9,660
Total	38,526	1,991,090	119,447	4,149,345	2,783	58,593

[1] Snider, L. C., Preliminary report on the lead and zinc of Oklahoma: Oklahoma Geol. Surv. Bull. No. 9, pp. 86–90, 1912.

REVIEW BY DISTRICTS.

Peoria district.—There was very little mining at Peoria, the site of the first lead and zinc mining in Oklahoma, in 1914, and the output of zinc carbonate and silicate was 61 tons less than in 1913. The ore was all obtained from shallow shafts on the Mountjoy land. The district is handicapped by lack of rail transportation.

Quapaw district.—Very few of the mines in this district were operated and others were only worked for a portion of the year. In consequence of this condition and the lower average price paid for sphalerite the value of the lead and zinc concentrates shipped declined from $46,037 in 1913 to $5,181 in 1914. The quantity of zinc concentrates shipped in 1914 was 949 tons less than in 1913, and only a few tons of galena and zinc silicate were shipped. Most of the ore shipped was produced by the Newlands Mining Co. and C. E. Miller from leases of the Iowa & Oklahoma Mining Co.

Miami district.—The mines of the Miami district in 1914 shipped 9,401 short tons of galena concentrates, valued at $443,493, and 28,219 short tons of sphalerite concentrates, valued at $921,647. This shows an increase of 1,691 tons of galena concentrates and of 5,201 tons of sphalerite concentrates when compared with the output of 1913. Although the average selling price of both lead and zinc concentrates was lower than in 1913, the total value of the concentrates shipped from Miami in 1914 was $242,050 greater than in 1913 and $727,537 greater than in 1912.

Moreover, the production in 1914 does not represent the maximum output that was attainable, for many of the mines were run single shift for a part of the year and no special effort was made to increase the yield of concentrates.

The quantity of crude ore mined and milled increased from approximately 525,000 tons in 1913 to 760,000 tons in 1914. The percentage of concentrates recovered from crude ore milled was larger than in any other district in the Joplin region, though with increased operations the "dirt" treated showed a natural decline in percentage of concentrates recovered. The average metal content of all of the blende concentrates sold increased from 51.8 per cent in 1912 to 53.6 per cent in 1913 and to 54.8 per cent in 1914. The separate assays reported showed the zinc content to range from 40 to 61.2 per cent, but most of the blende assayed between 52 and 58 per cent. The average selling price of galena concentrates declined from $52.91 in 1913 to $47.19 in 1914, and that of blende concentrates increased from $31.50 in 1913 to $32.66 in 1914. The unusual increase in the price paid for sphalerite was due partly to the higher zinc content, but mainly to the expiration of ore contracts which were in force in 1913. The recovery of galena concentrates from all the mines averaged about 1 ton to 3 tons of sphalerite, which is much higher than in any other district in the Joplin region. The proportion of galena concentrates recovered from the "dirt" mined showed wide variations, ranging in different mines from 1 ton of galena to 67 tons sphalerite as high as 1.1 tons of galena to 1 ton of sphalerite. The mines lying north of the original Miami camp reported 5,473 tons of galena and 10,738 tons of sphalerite, while those in the original Miami camp reported the production of only 3,871 tons of galena to 15,670 tons of sphalerite. The lowest proportion of galena to sphalerite was reported by the McConnell & Barnes mine at the extreme southwest corner of the district. This

new mine, and others southwest of Commerce and northwest of Miami, produced 57 tons of galena to 1,811 tons of sphalerite in 1914.

The approximate proportion of lead to sphalerite recovered in the three areas named in the preceding paragraphs was as follows: Original area, 1 of galena to 4 of sphalerite; northeastern and northwestern areas, 1 of galena to 2 of sphalerite; southwestern area, 1 of galena to 32 of sphalerite. It is probable that the working of more mines in the southwestern camp will increase the proportion of galena.

Prior to 1912 most of the ore was derived from the upper runs of ore, which varied from 90 to 130 feet in depth. By the end of the year 1911 much of the ore between these depths had been exhausted in many of the mines and, though several mines operated on the upper run of ore very successfully, an increased proportion of the ore treated in 1913 and 1914 was taken from a lower run of ore below the 200-foot level. The draining of the ground by the large centrifugal pump placed in a shaft on the Miami Zinc & Lead Co.'s lease on the Emma Gordon land gradually lowered the water level to 325 feet by the end of 1914, and ore was hoisted from levels as low as 250 feet in the southern mines of the camp. The ore hoisted from the mines in the northeastern and northwestern parts of the camp came from the average depths of 240 feet to 290 feet. The blende concentrates from the newly opened lower run in the southern area are of much better grade than those obtained from the upper ore run, which averaged about 50 per cent zinc.

The quantity of galena concentrates recovered at depths of 200 to 320 feet in the northern mines was much greater than that obtained from working the lower run of ore in the mines in the southern part of the camp.

Drilling operations were steadily carried on, not only ahead of the drifts in the mines opened and to explore the ore in lower levels at the old mines, but also in an extensive area reaching east to the vicinity of Tar Creek, north to the Kansas-Oklahoma State line, west of Commerce, and southwest across Neosho River. The percentage of prospect holes showing ore was larger than of those which were reported blank. The drilling was done by many land owners and lessees, including the Commerce Mining & Royalty Co., Church & Mabon, Picher Lead Co., Barnes & McConnell, T. T. Lennan, Longacre & Chapman, Denver Miami Mining Co., G. W. Peck, O. W. Sparks, Midas Mining Co., Standifer Bros., and Melrose Mining Co. Much of the drilling was done in the territory along Tar Creek and north toward the Kansas State line, but some was done on land northwest of Miami, and west and northwest of Commerce.

The 3,000 acres of land controlled by O. S. Picher, trustee, are located mainly in the territory immediately south of the Kansas State line in the northwestern part of T. 29, R. 23. Drilling was begun in October, 1913, with a definite plan of thorough exploration. From 5 to 10 churn drills were kept in constant operation and over 150 holes have been drilled under the direction of Victor Rakowsky, and a number of ore bodies have been blocked out. Two leases have been given to operating companies on which shafts are now being sunk. These two leases and other lands drilled are near the common section corner between secs. 16, 17, 20, and 21, all in township 29. The ore bodies are said to occur below 250 feet in the Grand Falls chert member of the Boone formation in synclines. The ore bodies show a remarkable uniformity both in thickness and in the constant occur-

rence of a layer of galena over the zinc ore. It is estimated that the mill recovery will show about 8 per cent in concentrates, of which one-fifth will be galena. In general, operators in the Joplin region have shown much carelessness in preserving drill records and cuttings taken from the drill holes. Mr. Rakowsky's methods of drill exploration and the manner in which the cuttings are kept for reference and inspection are worthy of emulation.

The new producing mines in 1914 northeast of the Lennan Lead & Zinc Co. were the Quapaw Mining Co., Blue Bird Mining Co., and the McConnell Lead & Zinc Co. Only a small quantity of ore from the Quapaw, which is a short distance northeast of the Lennan, was milled at the Lennan mill in 1914. A concentrating plant is now being erected at the mine. Northeast of the Quapaw mine the 150-ton mill of the Blue Bird Mining Co. built on the Fullerton & Dobson lease of the Cooper & Goodwin land and completed late in 1913, was operated during part of 1914. The ore mined was taken from the 175 to 180-foot levels by means of two shafts. Farther northeast on the west side of Tar Creek the 300-ton mill of the McConnell Lead & Zinc Co. was first operated in 1914. The mill shaft at this mine is 218 feet deep, and the northeast shaft, completed in 1914, is 200 feet deep.

About half a mile south of the McConnell mine on the Temple Chapman lease of the Commerce Mining & Royalty Co.'s property a new mine called the Cornfield was developed. A shaft was sunk and an ore body was mined at the 92 to 110-foot levels. Some ore, which was very rich in galena, was hoisted and stored, pending the construction of a 150-ton concentrating plant. This mill was not completed until early in 1915. Drilling disclosed ore at lower levels and shaft sinking has been resumed.

The mines on Emma Gordon leases produced about 46 per cent of the galena concentrates, and mines on Commerce leases yielded over 60 per cent of the sphalerite concentrates. The mines on Emma Gordon land that shipped concentrates in 1914 were the Standifer Mining Co., Carson Mining Co. (Oklahoma and Carson-Dodson mines), Thirty Acre Mining Co., Prairie Mining Co., and Lennan Zinc & Lead Co. At the original Emma Gordon mine Standifer Bros. mined ore at the 163-foot, 200-foot, and 240-foot levels by means of two shafts.

North of the Emma Gordon mine and connected by drifts the Carson Mining Co. had 6 shafts in operation working ground at levels between 260 and 290 feet. Two mills, having a total capacity of 325 tons and driven by power supplied by Bessemer gas engines, were used to concentrate the ore. The Thirty Acre Mining Co., directly north of the Carson Mining Co., had a 200-ton concentrating plant, which was destroyed by fire in October. The lease of the Prairie Mining Co. is directly east of the Carson and is equipped with a 250-ton mill and a 240-foot shaft.

North of the Prairie the Miami Lead & Zinc Co. has a 250-ton mill. The large pumping plant which so successfully lowered the water level in the district is situated on this lease.

Northeast and across the road on Commerce land is situated the Lennan Zinc & Lead Co.'s mine and 300-ton mill. The ore mined through the two shafts at this property in 1914 was taken from levels lower than those of any other mine in the camp.

The productive mines on leases in the immediate vicinity of Commerce, on land of the Commerce Mining & Royalty Co., were the

Cactus, Lost Trail, New State, Mizpah, Queen City-Joplin, Frosty Morning, Turkey Fat, Jeannette, King Jack, Never Sweat, Midas, Old Chief, and Miami Amalgamated (Sullivan). Of these mines the Mizpah, Cactus, King Jack, Turkey Fat, and Never Sweat mines were operated by the controlling interests in the Commerce Mining & Royalty Co. The largest outputs were made from the Mispah, Lost Trail, Never Sweat, and Turkey Fat mines. The Tango mine was under development and will be equipped with a mill in 1915.

Two new mines being developed on Commerce land are the Blue Goose and the Haymaker in the northern portion of the district. Two 200-foot shafts were sunk on the Haymaker, and a mill will be built in 1915.

Southwest of Commerce some lead and zinc concentrates were recovered by means of hand jigs by the Hubert Mining Co., on the McCuddy, Crang & Co.'s land. Farther southwest and about 1½ miles northwest of the city of Miami is the camp locally termed Horse Shoe Lake. This is the most southwestern producing area in the Miami district and was first prospected by McConnell & Barnes in 1913. After considerable drilling two shafts were sunk and a 200-ton concentrating plant was built, which was first run in the spring of 1914. The sphalerite produced had a zinc content of 60 to 61 per cent and the output was large. Slightly northeast on an adjoining lease of McConnell & Barnes the O. W. Sparks Mining Co. has a 75-foot shaft from which a large quantity of "dirt" was hoisted. The ore was treated by means of four hand jigs and the yield, mainly of high-grade sphalerite, was very large for the equipment used and the labor employed.

The Denver Miami Mining Co. drilled the lease northeast of the Sparks mine. Good ore was found at about 220 feet and a shaft was sunk. A contract has been made for the erection of a concentrating plant which will be in operation in 1915.

SOUTHERN AND CENTRAL OKLAHOMA.

Murray County.—No production of zinc concentrates was reported from the Arbuckle Mountain district in 1914. A description of this region, the ore occurrence, and the development of the mines was given in this report for 1912.

McClain County.—The production of silver in Oklahoma increased in 1914 from 1,300 fine ounces, valued at $785, to 6,187 fine ounces, valued at $3,421. The ore shipped in 1913 and 1914 was mined by C. T. Criswell, of Byars, in McClain County, from land owned by him, located about 5 miles west of Byars, on the SW. ¼ sec. 33, T. 5, R. 3 E., about 100 yards north of the boundary line between Garvin and McClain counties. The ore deposits lie on the side of a canyon running north and south, and there is evidence that there was prospecting here before the present owner of the property purchased it. The ore shipped in 1914, amounting to 190 tons, was obtained from an open cut 8 feet deep and was hand sorted before shipment. The ore, which is a light-gray decomposed sandstone, containing silver chloride and a small quantity of copper, has averaged about 33 to 37 ounces of silver a ton. The production from this mine is notable for the reason that it is the only mine in the Central States in which silver is the predominant value in the ore.

WISCONSIN.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Wisconsin in 1914 is shown in the following table:

Production of lead and zinc in Wisconsin in 1914, by districts, in short tons.[a]

District.	Ore.					
	Lead concentrates (galena).		Zinc concentrates.			
			Sphalerite.		Carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Benton	687	$27,578	45,869	$764,631	.....	.....
Cuba City	20	977	2,264	39,676	.....	.....
Dodgeville	12	532	705	13,609	.....	.....
Hazel Green	322	12,600	25,547	438,112	.....	.....
Highland	104	3,862	276	7,598	2,118	$29,689
Linden	569	26,319	6,470	120,373	.....	.....
Livingston	82	3,469	16,347	274,503	.....	.....
Mifflin	56	2,545	6,915	171,993	.....	.....
Mineral Point	.....	.....	.....	.....	614	7,694
Montfort	82	3,265	1,031	28,958	.....	.....
Platteville	32	1,280	2,665	54,037	55	650
Shullsburg	62	2,769	446	10,636	.....	.....
State total:						
1914	2,028	85,196	108,535	1,924,126	2,787	38,033
1913	[b] 2,532	125,197	95,540	2,053,341	3,123	30,769
1912	3,373	180,661	102,617	2,908,892	4,370	72,800
1911	4,359	229,465	93,963	1,929,123	5,035	74,143
1910	5,608	286,493	89,232	1,750,574	5,269	69,588
1909	4,659	254,514	65,421	1,505,752	5,130	63,603
1908	5,246	277,334	48,155	998,734	3,206	36,579
1907	4,408	266,471	47,251	997,127	3,065	40,422

District.	Metal content.			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Benton	495	$38,610	12,606	$1,285,812
Cuba City	16	1,248	609	62,118
Dodgeville	8	624	231	23,562
Hazel Green	228	17,784	6,935	707,370
Highland	69	5,382	609	62,118
Linden	446	34,788	1,947	198,594
Livingston	60	4,680	4,042	412,284
Mifflin	43	3,354	2,560	261,120
Mineral Point	.....	.....	128	13,056
Montfort	57	4,446	382	38,964
Platteville	24	1,872	891	90,882
Shullsburg	48	3,744	173	17,646
State total:				
1914	1,494	116,532	31,113	3,173,526
1913	1,866	164,208	30,110	3,372,320
1912	2,581	232,290	33,050	4,560,900
1911	3,353	301,770	29,720	3,388,080
1910	4,413	388,344	25,927	2,800,116
1909	3,694	317,684	23,152	2,500,416
1908	4,138	347,592	18,206	1,711,364
1907	3,499	370,894	18,490	2,181,720

[a] In calculating the metal content of the ores from assays allowance has been made for smelting and concentration losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer and that the value of the metal is calculated from the average daily quotations at New York and St. Louis.

[b] Includes a few tons of lead carbonate.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1913 and 1914.

		1913	1914
Total crude ore	short tons	1,406,000	1,387,490
Total concentrates in crude ore:			
Lead	per cent	0.18	0.14
Zinc	do	7.04	8.02
Metal content in crude ore:			
Lead	do	.13	.11
Zinc	do	2.6	2.8
Average lead content of galena concentrates	do	74.8	73.7
Average zinc content of sphalerite concentrates	do	38.0	35.05
Average zinc content of zinc carbonate concentrates	do	23.0	27.5
Average value per ton:			
Galena concentrates		$49.16	$42.01
Sphalerite concentrates		$21.53	$17.73
Zinc carbonate concentrates		$9.85	$13.65

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and comprise the most important part of the ore deposits of the upper Mississippi Valley region, a historical review of which is given in the Illinois section of this report. A detailed description of the Wisconsin lead and zinc districts and of the mines in each district to the year 1906 is given by Bain.[1] Although mining development has continued and many new mines have been opened, worked out, and abandoned, the area of the mining region has not been enlarged to any extent. The development of the mines subsequent to Bain's report and the output of Wisconsin mines have been given in the reports in Mineral Resources of the United States for the years 1907 to 1913.

The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite or zinc blende and smithsonite or zinc carbonate, the last locally known as "dry bone." As a lead region the district has been known from the earliest settlement days. In time the building of smelters near by made a market for the zinc ores. The first zinc ore to be mined was the carbonate found in association with lead in the shallow working above ground-water level. When all the main deposits were worked out down to water level there was a lull in mining in the region. Though the carbonate was known to give place to zinc blende and the lead to continue on below water, it was not deemed profitable to mine when continued pumping was necessary. About 8 or 10 years ago the higher price of zinc led to the opening of some of the deposits below water level, since which time zinc mining has increased until Wisconsin in 1911 and 1912 stood third and in 1913 and 1914 fourth in rank among zinc-producing States. The ore bodies are found in perpendicular, horizontal, or inclined cavities known as "openings" or "crevices," "flats," and "pitches." These openings sometimes extend for a considerable distance in a straight line called a "range," and may be operated at different places by different companies. When a range is once established it becomes an important guide in prospecting.

The galena of the district is nonargentiferous, and so far as known the zinc ores are free from cadmium. In some of the mines marcasite is so plentiful that the zinc blende concentrates are reduced to

[1] Bain, H. F., Zinc and lead deposits of the upper Mississippi Valley: U. S. Geol. Survey Bull. 294, pp. 81–148, 1906.

a very low grade. Owing to their nearness in specific gravity, marcasite and blende are very difficult to separate cleanly by hydraulic methods. Both electrostatic and electromagnetic separation proccesses have been used.

Very few of the concentrating plants in the district are equipped with roasters and magnetic separators and the companies constructing milling plants in 1914 did not report the erection of roasters. It is believed by many mine owners that it is more economical to sell the green concentrates than to invest in a roasting plant, entailing the employment of extra shifts of men during the entire day of 24 hours. The Linden Zinc Co. operate a roaster and magnetic separator at Linden to treat ores from the Optimo No. 1 and No. 2 mines owned by affiliated interests. The Mineral Point Zinc Co. operate a roaster and magnetic separator at Mineral Point, Wis., and green concentrates are treated by the Wisconsin Separating Co. at Benton, the National Zinc Separating Co. at Hazel Green, the Empire roaster at Platteville, and the Campbell Magnetic Separating Co. at Cuba City. The last-named plant, now controlled by the Wisconsin Zinc Co., and that of the Linden Zinc Co. use a patented process which requires the ore to be only slightly roasted and which recovers the marcasite and pyrite in shape for sale to acid manufacturers.

At the other plants the concentrates, after being dried, are roasted, the customary form of roaster being a long, slowly revolving cylinder lined with fire brick. The roasting is carried far enough to render the marcasite magnetic, but not to drive off all the sulphur, after which the concentrates are passed under a magnetic separator, which removes the iron.

The multiplication of individual and custom roasters, by raising the low-grade ore to high grade, has a tendency to reduce relatively the quantity of zinc concentrates shipped to smelters, though, of course, the metal content and the value will be less affected; hence these last must serve as the basis of comparison for different years. It is rather difficult to estimate the exact quantity of green ore treated at separating plants, as the Mineral Point Zinc Co. operate an oxide plant and also a separating plant at Mineral Point, and a portion of the green ore purchased is used at the oxide works without being treated at the separating works. Probably more than 80 per cent of the sphalerite concentrates shipped by mines in Wisconsin in 1914 went to separating companies.

The average zinc content of the sphalerite concentrates sold in 1910 was 34.8 per cent and the average price per ton was $19.62; the corresponding content and price for 1911 were 34.6 per cent and $20.53; for 1912, 38.4 per cent and $28.34; for 1913, 38 per cent and $21.53; and for 1914, 35.05 per cent and $17.73.

Milling practice is much as in the Joplin region, except that in Wisconsin everything has been on a smaller scale. Mills of 100 tons or more, with rougher, cleaner, sand jigs, and concentrating tables, have generally been built in the last few years, and the tendency is to build plants of larger capacity. Most of the plants built by the large operators during the last two years have a capacity (10-hour shift) of 150 tons or more.

The percentage of concentrates recovered from crude ore is much higher than in the Joplin region, but the zinc concentrates average 20 to 22 per cent less in zinc content. On account of these condi-

tions, at many mines no close recovery is made and the tailings, containing large quantities of zinc, are seldom reworked.

The mills erected in 1914, with their reported capacity (10-hour shift) and location, were the following: Mineral Point Zinc Co. (Penna-Benton mine), 200 tons, and Wisconsin Zinc Co. (Champion mine), 300 tons, at Benton; Mineral Point Zinc Co. (Little Coker mine), 300 tons, at Livingston; B. M. & B. Mining Co. (Biddicke mine), 100 tons, at Mifflin; West Hill Mining Co. (Stephens land), 50 tons, and Kistler Mining Co. (Alderson land), 100 tons, at Platteville.

The crude ore yields from 5 to more than 20 per cent of concentrates. The mining methods are largely determined by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin.

The zinc carbonate ore, which is mined principally in the Highland and Mineral Point districts, is purchased by the Mineral Point Zinc Co. and made into zinc oxide in the plant at Mineral Point, Wis. A considerable quantity of the low-grade zinc blende concentrate is used in the same way.

The metal content of the sphalerite concentrates sold by the mines varied in 1914 from 19 per cent to 58 per cent. The larger portion of the concentrates sold ranged between 30 and 46 per cent.

The value of the mine output of copper, silver, lead, and zinc in Wisconsin for the year 1914 was $3,291,437, against $3,536,528 in 1913, a decrease of $245,091.

The lead concentrates sold declined from 2,532 tons, valued at $125,197, in 1913, to 2,028 tons, valued at $85,196, in 1914. The sphalerite concentrates sold increased from 95,540 tons to 108,535 tons, but the value of such concentrates decreased from $2,053,341 to $1,924,126.

The quantity of zinc carbonate concentrates shipped decreased from 3,123 tons in 1913 to 2,787 tons in 1914, but the value increased from $30,769 to $38,033.

The metal content of the lead concentrates in 1914 was 372 tons less than in 1913. The recoverable zinc content of the sphalerite and zinc carbonate concentrates increased 1,003 tons over that of 1913, but the value was $198,794 less.

The small production of silver (16 ounces) and of copper (10,300 pounds) was derived from copper ore shipped from near Dunbarton, in Lafayette County. It is the only output of these metals recorded from Wisconsin for many years.

The Benton district was much the largest producer of both galena and sphalerite concentrates, its output being almost double that of Hazel Green, the next largest producing district. The mines in these two districts yielded about two-thirds of the sphalerite and one-half of the galena concentrates shipped by Wisconsin mines in 1914. Benton, Hazel Green, Mifflin, and Livingston were the only districts in Wisconsin that had a larger production in 1914 than in 1913. The quantity of ore treated was about the same in 1914 as in 1913. The quantity of sphalerite concentrates recovered was larger than in 1913, but the average zinc content declined from 38 per cent in 1913 to 35.05 per cent in 1914, and the average price per ton paid for sphalerite decreased from $21.53 in 1913 to $17.73 in 1914. The

average zinc content and the price of the carbonate concentrates showed an increase, but no fair comparison is possible, for the shipments in 1913 included a large quantity of sludge shipped from the Franklin and other mines at Highland. The galena concentrates sold in 1914 contained a slightly lower lead content, and the average price was more than $7 less than in 1913.

Although the production in Wisconsin in 1914 was considerably greater than in 1913, the number of producing mines did not increase. Drilling was active in several of the camps, but in a large measure it was done by the old companies. The number of newly developed mines equipped with mills or sufficiently advanced in development to warrant the erection of concentrating plants was not large, and such properties were mainly situated in the Benton district and near Platteville. The larger mining interests in the field, which include the Mineral Point Zinc Co., Wisconsin Zinc Co., Vinegar Hill Zinc Co., Cleveland Mining Co., Frontier Mining Co., Field Mining & Milling Co., and Optimo Mining Co. had a combined output approximately equal to 61 per cent of all the lead concentrates and 85 per cent of all the zinc concentrates shipped from Wisconsin mines in 1914. These same companies shipped 44 per cent of all the lead concentrates and 77 per cent of all the zinc concentrates in 1913.

The new development work done, the new producing mines, the new mills, and the transfers of ownership are set forth under the reviews by districts. For descriptions of the old mines and concentrating plants on which no essential changes were made during 1914, the reader is referred to the corresponding section of this report for 1913.

REVIEW BY DISTRICTS.

Benton district.—This district, which had much the largest output in the State, produced about 33 per cent of the galena concentrates and 42 per cent of the sphalerite concentrates sold in Wisconsin in 1914. The quantity of galena concentrates was 136 tons less and that of zinc concentrates 15,069 tons more in 1914 than in 1913. The total value of all concentrates sold in 1914 was $792,209, against $720,993 in 1913. In addition to the shipments of lead and zinc concentrates about 12,000 tons of marcasite were shipped. More new properties were developed and equipped than in other districts.

The largest quantity of sphalerite concentrates was shipped from the Winskill, Fox, Martin, and Crawhall mines, in the order named. As the zinc content of the sphalerite shipped from the district was as low as 19 per cent and as high as 46 per cent, the rank of the principal producing mines according to value of output was as follows: Martin, Winskill, Crawhall, Grotkin, and Fox. The only producing mine of the Field Mining Co. was that on the Crawhall land, which had a large yield of sphalerite and also produced about one-third of the galena shipped from the Benton district. Additional drilling was done on the Thompson land, and a 6 by 15 shaft was sunk 115 feet during the year. The total depth of this shaft will be 230 feet, and a concentrating plant of 600 tons' capacity (24 hours) is under construction. The Field Mining & Milling Co. also drilled 37 holes on the Coulthardt leases and 18 on the Monroe lease. No development followed the drill exploration.

The Acker Mining Co. drilled the Gray land and sunk two prospect shafts. No output was made other than a small quantity of galena, which was not sold.

The Frontier Mining Co. was one of the largest shippers in the district. Ore was mined from the Grotkin, Robson, and Calvert leases. Development work was confined to the producing properties, but the Hird shaft will be sunk in 1915. The Brookside Milling Co. made a considerable quantity of concentrates from tailings on Frontier leases. The Indian Mound Mining Co.'s mine on the Monroe land was operated steadily and made a good output of galena and sphalerite concentrates. The Mineral Point Zinc Co. not only operated the Fox mine, one of the largest producers of low-grade sphalerite in Wisconsin, but also developed the Penna-Benton mine on the Leckley land and equipped it with a 200-ton mill, which was started late in the year. The Sans Souci Mining Co., which purchased the old Eureka mill in 1913, first operated its mine and mill in 1914. The mine is on land belonging to the Lafayette Land Co., and the shaft is 75 feet deep.

The Vinegar Hill Zinc Co. operated the Wilkinson and Martin mines and made a good output of galena and sphalerite. In addition to the output of galena and blende concentrates a large quantity of marcasite, averaging 44.15 per cent of sulphur, was shipped from the Wilkinson mine. The blende concentrates derived from the ore from the Wilkinson mine have a much lower zinc content than those from the ore of the Martin mine.

The Martin mine, which is at Strawbridge, 3 miles south of Benton, was developed in 1913. The Whaley land was prospected with drills, but was not developed. Longhenry Bros. continued the development of the Spenceley land and sunk shaft No. 5 to a depth of 94 feet. Some high-grade ore was taken out in sinking, but no sales were made. There are over 50 drill holes on the 110-acre lease, on which a concentrating plant will probably be built in 1915.

The Wisconsin Zinc Co. operated the Winskill mine, which continued to yield a large output of both lead and zinc. A 160-foot shaft was put down on the Champion lease, acquired in 1913, and a 300-ton mill was built, which was started late in the year. The C. A. Thompson land was prospected by means of churn drills. It is stated that good ore bodies were found and that a large milling plant will be erected. Small shipments of lead or zinc ore were made from mines of the Grand View Mining Co. and the Piquette Mining Co., neither of which are equipped with concentrating plants.

Cuba City-Elmo district.—The production of lead concentrates in 1914 in this district was 169 tons less than in 1913, and that of sphalerite was 7,139 tons less than in 1913. Most of the output in 1914 came from the Mausbruk mine of the Vinegar Hill Zinc Co. Several mines formerly very productive were closed throughout the year.

The National Zinc Separating plant of the Vinegar Hill Zinc Co. and the Campbell Magnetic Separating Co., controlled by the Wisconsin Zinc Co., were operated steadily, and over 20,000 tons of concentrates were treated. The Beloit Elmo mine of the Midland Lead & Zinc Co. made only a small production, and the Long Range Mining Co.'s mines on the Banfield land were idle.

Dodgeville district.—The production of lead concentrates decreased in this district from 33 tons in 1913 to 12 tons in 1914 and the output

of sphalerite increased from 250 tons in 1913 to 705 tons in 1914. The Lucky Five Mining Co., on the Davis land and the Thomas land was the largest producer of concentrates. The shaft at this mine is 100 feet deep, and the concentrator has a capacity of 50 tons. Some prospecting was done and a new shaft was sunk at the Henry T. Roberts mine on the Berryman land, but no shipments were made.

Some of the smaller shippers of concentrates were B. Davis, George Evans, P. Owens, T. Edwards, C. Guthrie, J. Davey, and D. Williams.

Hazel Green district.—Although there were only three producing properties in this district in 1914, the production of lead concentrates was 322 tons and that of sphalerite concentrates was 25,547 tons. The district ranked second in point of production in Wisconsin in 1912, 1913, and 1914. The quantity of both lead and zinc concentrates shipped in 1914 was much larger than in 1913, the increase in the quantity of sphalerite amounting to more than 7,000 tons. The Kennedy mine of the Mineral Point Zinc Co. was the largest shipper of sphalerite, but the value of its production was exceeded by that of the Cleveland Mining Co. and by that of the Federal mine of the Wisconsin Zinc Co. The Lawrence mine of the Cleveland Mining Co. is now being equipped and will be worked in 1915. There were no special changes in the operation or equipment of the large producing properties in 1914. The Pearce land was drilled by the McMillan Mining Co. and a mill, which will be erected in 1915, was purchased.

Highland district.—The Mineral Point Zinc Co. controls most of the mining lands in this district and operates a mill of large capacity at the Highland mine. The only other concentrating plants in the district are two small ones on the St. Anthony Mining & Milling Co.'s land. The shipments in 1914 of all classes of concentrates were slightly more than in 1913. The concentrates sold were, as usual, mainly composed of zinc carbonate, but a considerable quantity of hand-jigged sphalerite was sold by Lampe & Steppler and by Kennedy & Egan. All of the ore mined is derived from levels above 100 feet, and most of the shafts are less than 70 feet in depth.

The producing leases on the St. Anthony land were those of Mulderney & Gunn, Chaney & Co., and William Wenken. Other producers were the John Schaack Mining Co. on the Williams land, lessees of the Burrichter Mining Co., B. Topp & Co., on the Gilliam land, Henry Hying on the Flynn land, and the Web King Mining Co.

Linden district.—In 1914 the production of galena concentrates increased 156 tons and that of sphalerite decreased 4,245 tons, when compared with the production in 1913. Optimo No. 2 on the Smith land, first operated in 1913, was the largest producer in the Linden district. The mill at this mine has a capacity of 100 tons and is operated by electric power. The Campbell patented process is used at the plant of the Linden Zinc Co., which treated green concentrates from the Optimo mines. In addition to shipping sphalerite having a zinc content of 59 per cent, the Optimo Co. sold a quantity of marcasite to acid manufacturers.

Ross Bros. sold the largest quantity of galena concentrates and the second largest quantity of sphalerite concentrates in the district in 1914. The shaft at this mine is 125 feet deep, and the concentrating plant has a capacity of 60 tons.

The Glanville Mining Co.'s lease on the W. M. Smith land was a producer of sphalerite and galena. Four shafts and a 50-ton mill were operated.

The Saxe Pollard Mining Co. operated the mine and concentrating plant on the Weigle land during the first three months of 1914, but the property was idle the remainder of the year. The Gribble Harker Mining Co. was idle, and the shipments made by the Tango Mining Co. were small. The Heathcock land was prospected by C. W. Singer, who drilled 18 holes and had a shaft in ore at the end of the year.

Livingston district.—The production of sphalerite in this district increased from 11,940 tons in 1913 to 16,347 tons in 1914, and the district was the third largest producer of sphalerite in Wisconsin.

The Coker mine of the Mineral Point Zinc Co., which was the largest producer of both lead and zinc, was operated steadily throughout the year. The Little Coker mine was opened, and a 300-ton (10-hour shift) mill was erected, which was first operated in October, 1914. Both the Ellsworth mine on land owned by the Mineral Point Zinc Co. and a new mine on the Rundell land were worked by the Vinegar Hill Zinc Co. Ore from both properties, but mainly from the Rundell, were treated at the 150-ton mill at the Ellsworth mine.

Mifflin district.—The output of Mifflin district in 1914 was 56 tons of galena concentrates, valued at $2,545, and 6,915 tons of sphalerite concentrates, valued at $171,993. The shipments of galena in 1914 were 12 tons more than in 1913, and those of sphalerite increased 2,454 tons.

The Lucky Six Mining Co.'s shipments of sphalerite amounted to about one-third of the district total. Two shafts were used and ore was hoisted from the 80-foot level below the glass rock. At this mine the waste rock is not hoisted, being culled out and used to support the roof in the drifts.

The Grunow Mining Co. operated the mine and mill on the Bainbridge land and have leased the Clayton mine. The Peacock mill, which had been driven by power supplied by a gasoline engine, changed to electric drive. The production from the Shamrock and the Peni mines was less than in 1913, and there was no new development work accomplished at the B. M. & B. Mining Co.'s lease on the Clark land. The Biddicke lease was equipped with a concentrating plant, which was completed about the end of 1914.

Mineral Point district.—All the concentrating plants in this district were idle in 1914, and the only production was that made by a number of small operators. Part of the concentrates came from that section of the district known as Barreltown, and the output was purchased by the Mineral Point Zinc Co. The average zinc content of the ore shipped was slightly more than 30 per cent. The largest producers in 1914 were Ross & Doney; Grange & Co.; Kinsman & Davis; Mitchell & Sons; Quier Paulus & May; May & Rink; and E. & F. Ellsworth.

Montfort district.—The shipments of sphalerite concentrates in 1914 were slightly less than in 1913. The O. P. David Mining Co. was again the largest producer. The ore, which is of good grade, was hoisted by means of 2 shafts, each 127 feet deep, and was concentrated at a 60-ton mill, which was operated until October, 1914. The Red Jacket mine of the Mineral Point Zinc Co. was idle all the year.

Platteville district.—The mine production of this district in 1914 was the smallest for many years. The output was mainly that of the East End mine, and the only other mines working were the Klar Piquette and the West Hill. Some development was done on the Seitz land by the Wisconsin Zinc Co., and the 50-ton mill at the West Hill mine on the Stephens land, erected in 1913, was operated for part of the year. The Wilson mine, near Potosi, and the Hodge and Enterprise mines, in the city of Platteville, were idle. The Kistler Mining Co. sunk a new 125-foot shaft on the Alderson land and built a 100-ton concentrating plant, but made no shipments of concentrates.

Shullsburg district.—The shipments of galena concentrates from this district declined from 368 tons in 1913 to 62 tons in 1914 and those of sphalerite from 1,347 tons to 446 tons. The only producing mines were the Farrey Queen, Rodham, and Milwaukee-Shullsburg, which were operated intermittently.

COPPER MINING IN SOUTHWESTERN WISCONSIN.

The existence of small deposits of copper ore in southwestern Wisconsin has been known for many years and several such occurrences are described by Strong.[1] Small shipments of ore were made from some of the mines as early as 1856. No shipments of copper ore have, however, been reported to the United States Geological Survey until 1914, when the Clover Hill Mining Co., controlled by W. B. Robertson, of Dubuque, Iowa, reported the shipment of about 37 tons of copper ore to Omaha. This copper ore, which was mainly chalcopyrite mixed with hematite and sandy clay, was taken from an old dump and from a shaft which was sunk to the depth of 45 feet on the Troy farm in sec. 36, T. 2 N., R. 3 E., in Lafayette County. This copper prospect is about 4 miles northeast of Dunbarton and 3 miles northwest of Gratiot, and Mr. Robertson states that it is the same mine or prospect described by G. H. Cox.[2] The 37 tons of ore shipped yielded, approximately, 10,300 pounds of copper and 16 ounces of silver.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES.[3]

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Bain, H. F., Lead and zinc deposits of Illinois: Bull. 225, pp. 202–207, 1904. 35 cents.

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——— Zinc and lead ores in 1905: Mineral Resources U. S. for 1905, pp. 379–392, 1906. $1.

——— Zinc and lead deposits of northwestern Illinois: Bull. 246, pp. 56, 1905. 15 cents.

[1] Strong, Moses, Geology of Wisconsin, 1873–1879, vol. 4, pt. 1, pp. 69–72, 1882.

[2] Cox, G. H., Min. and Sci. Press, vol. 99, p. 592, Oct. 30, 1909.

[3] The publications for which a price is given are no longer available for free distribution but can be purchased from the Superintendent of Documents, Washington, D. C.; others can be obtained free on application to the Director of the United States Geological Survey. Some are out of print but may be examined in libraries.

BAIN, H. F., Zinc and lead deposits of the upper Mississippi Valley: Bull. 294, 155 pp., 1906. 75 cents.
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——— Tests for gold and silver in shales from western Kansas: Bull. 202, 21 pp., 1902. 5 cents.
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GOLD, SILVER, AND COPPER IN ALASKA IN 1914.

(MINES REPORT.)

By Alfred H. Brooks.

INTRODUCTION.[1]

The certainty of railway connection with the Yukon Basin and the probability of an early opening of the coal fields greatly stimulated the development of and search for gold and copper deposits in Alaska during 1914. On the other hand, the financial depression following the outbreak of the European war led to the curtailment of many operations, notably those on copper deposits.

Lode mining in the Juneau gold belt continues to overshadow all other lode operations in the magnitude of the plants either operated or being installed. The development of copper deposits in the Ketchikan district made notable advances during the year. There was also much development work done on gold and copper ores in the Prince William Sound region. The Willow Creek lode district had a very prosperous season, though the plants thus far built are small. In the eastern part of the Kotsina-Chitina copper belt two mines were on a productive basis, and the equipment installed on a third assures its becoming a regular shipper in 1915. There is every promise that the output from both copper and gold lode mines will be greater in 1915 than it was in 1914.

Less evidence of lasting prosperity was shown by the placer-mining industry. There was indeed an increased output of gold from the Ruby, Hot Springs, and Seward Peninsula districts and from smaller districts. In the first two the increase was due to the exploitation of bonanza placers that in themselves do not necessarily give promise of large operations. The Fairbanks placer gold production is gradually declining, nor is it likely that permanent improvement of placer-mining industry in this field will take place until lower operating costs are brought about by improved methods and by cheaper fuel and transportation. On the other hand, there was an increase of gold dredging on Seward Peninsula, and in other placer districts there was much prospecting of dredging ground.

The discovery of two new districts believed to carry placer gold caused some excitement in 1914. One lies in the headwater region of Tolovana, where the prospecting so far done has given encouragement to the miner. The other is in the lower Healy River basin,

[1] Aid has been rendered in the preparation of this report by E. M. Aten, who has assisted in the collection of statistics from mines. The data on mining development here presented are all taken from United States Geological Survey Bulletin 622, which deals with the region in a more detailed way.

where, although some placers appear to have been found, the outlook for any considerable mining is reported to be not encouraging.

In this report, as in the reports for previous years, the attempt has been made to base statistics of output, as far as possible, on statements of individual producers, the only reliable source of information. Though the cordial cooperation of most of the important mine operators has been secured, there are still a few large producers of placer gold and many smaller ones who neglect to reply to the Survey request for information. In connection with this work the writer is under special obligations, for valuable information, to the Director of the United States Mint, to the collectors of the customs service, to the many United States commissioners in the Territory, to officials of banks and of transportation companies, and to prominent residents. All these data have been carefully sifted, and the accompanying figures are based upon them.

The limit of error of the statement of the total gold production of the Territory is believed to be within 2 per cent. In the crediting of the proper amounts to individual districts, however, the error may be in some cases as high as 8 per cent.

PRODUCTION.

The production of gold, silver, and copper in Alaska for 1913 and 1914 are shown in the following table:[1]

Mine production of gold, silver, and copper in Alaska, 1913–14.

Year.	Gold.		Silver.		Copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces		*Fine ounces*		*Pounds.*		
1913	755,947	$15,626,813	362,563	$218,988	21,659,958	$3,357,293	$19,203,094
1914	762,596	15,764,259	394,805	218,327	21,450,628	2,852,934	18,835,520
Increase (+) or decrease (−)	+6,649	+137,446	+32,242	−661	−209,330	−504,359	−367,574

The following table is an estimate of the total production of gold, silver, and copper in Alaska since the beginning of auriferous mining in 1880. For the early years the figures are probably far from being correct, but they are based on the best information now available.

[1] According to C. E. Siebenthal, the smelter reports showed a return of 6 tons of lead from Alaska ores in 1913, valued at $528, and none in 1914.

Production of gold, silver, and copper in Alaska, 1880–1914.

Year.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Commercial value.	Quantity.	Value.
	Fine ounces		*Fine ounces*		*Pounds.*	
1880	967	$20,000				
1881	1,935	40,000				
1882	7,256	150,000				
1883	14,561	301,000	10,320	$11,146	3,933	$826
1884	9,724	201,000				
1885	14,512	300,000				
1886	21,575	446,000				
1887	32,653	675,000				
1888	41,119	850,000	2,320	2,181		
1889	43,538	900,000	8,000	7,490		
1890	36,862	762,000	7,500	6,071		
1891	43,538	900,000	8,000	7,920		
1892	52,245	1,080,000	8,000	7,000		
1893	50,213	1,038,000	8,400	6,570		
1894	62,017	1,282,000	22,261	14,257		
1895	112,642	2,328,500	67,200	44,222		
1896	138,401	2,861,000	145,300	99,087		
1897	118,011	2,439,500	116,400	70,741		
1898	121,760	2,517,000	92,400	54,575		
1899	270,997	5,602,000	140,100	84,276		
1900	395,030	8,166,000	73,300	45,494		
1901	335,369	6,932,700	47,900	28,598	250,000	40,000
1902	400,709	8,283,400	92,000	48,590	360,000	41,400
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000
1904	443,115	9,160,000	198,700	114,934	2,043,586	275,676
1905	756,101	15,630,000	132,174	80,165	4,805,236	749,617
1906	1,066,030	22,036,794	203,500	136,345	5,871,811	1,133,260
1907	936,043	19,349,743	149,784	98,857	6,308,786	1,261,757
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267
1909	987,417	20,411,716	147,950	76,934	4,124,705	536,211
1910	780,131	16,126,749	157,850	85,239	4,241,689	538,695
1911	815,276	16,853,256	460,231	243,923	27,267,878	3,408,485
1912	829,435	17,145,951	515,186	316,839	29,230,491	4,823,031
1913	755,947	15,626,813	362,563	218,988	21,659,958	3,357,293
1914	762,596	15,764,259	394,805	218,327	21,450,628	2,852,934
Total	11,811,084	244,156,799	3,851,416	2,278,518	133,404,063	19,780,452

The subjoined table is an estimate, based on the best available data, of the source of the gold and silver produced in Alaska since mining began in 1880. Gold valued at about $65,100,000, or nearly a third of the total output, was produced prior to 1905, and there is but scant information about the source of it. Since that time fairly complete statistical returns are available, and it is believed that the figures presented in the following table are near enough the truth to have value. The figures presented in this table of the silver recovery from placer gold and from siliceous ores are probably less accurate than those of the gold. Copper mining did not begin in Alaska until 1901, and the figures here presented for the gold and silver derived from copper ores should therefore be a close approximation to the actual output.

Sources of gold and silver in Alaska, 1880–1914, by kinds of ore.

	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
	Fine oz.		*Fine oz.*	
Siliceous ores	3,264,787	$67,489,141	894,847	$622,533
Copper ores	46,181	954,666	1,462,348	840,029
Placers	8,500,116	175,712,992	1,494,221	815,956
Total	11,811,084	244,156,799	3,851,416	2,278,518

The value of the gold produced in Alaska in 1914 is estimated at $15,764,259 and of the silver at $218,327; the number of ounces of gold at 762,596 and of silver at 394,805. In 1913 the output of gold was valued at $15,626,813. The copper output of Alaska for 1914 is estimated at 21,450,628 pounds, valued at $2,852,934; that of 1913 was 21,659,958 pounds. Comparison is made in the following table between the gold production of 1913 and 1914 by regions:

Value of production of gold in Alaska, 1913 and 1914, by regions.

Region.	1913	1914	Increase +, decrease −.
Pacific coast belt, including southeastern Alaska and Prince William Sound	$4,529,529	$4,538,157	+ $8,628
Copper River and Cook Inlet region	378,643	597,681	+219,038
Yukon and Kuskokwim basins	8,183,641	7,895,421	−288,220
Seward Peninsula and northwestern Alaska	2,535,000	2,733,000	+198,000
Total	15,626,813	15,764,259	+137,446

Value of gold production of Alaska, with approximate distribution, 1880–1914, by regions.

Year.	Pacific coast belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula and northwest Alaska.	Total.
1880	$20,000				$20,000
1881	40,000				40,000
1882	150,000				150,000
1883	300,000		$1,000		301,000
1884	200,000		1,000		201,000
1885	275,000		25,000		300,000
1886	416,000		30,000		446,000
1887	645,000		30,000		675,000
1888	815,000		35,000		850,000
1889	860,000		40,000		900,000
1890	712,000		50,000		762,000
1891	800,000		100,000		900,000
1892	970,000		110,000		1,080,000
1893	838,000		200,000		1,038,000
1894	882,000		400,000		1,282,000
1895	1,569,500	$50,000	709,000		2,328,500
1896	1,941,000	120,000	800,000		2,861,000
1897	1,799,500	175,000	450,000	$15,000	2,439,500
1898	1,892,000	150,000	400,000	75,000	2,517,000
1899	2,152,000	150,000	500,000	2,800,000	5,602,000
1900	2,606,000	160,000	650,000	4,750,000	8,166,000
1901	2,072,000	180,000	550,000	4,130,700	6,932,700
1902	2,546,600	375,000	800,000	4,561,800	8,283,400
1903	2,843,000	375,000	1,000,000	4,465,600	8,683,600
1904	3,195,400	500,000	1,300,000	4,164,600	9,160,000
1905	3,430,000	500,000	6,900,000	4,800,000	15,630,000
1906	3,454,794	332,000	10,750,000	7,500,000	22,036,794
1907	2,891,743	275,000	9,183,000	7,000,000	19,349,743
1908	3,448,318	401,500	10,323,000	5,120,000	19,292,818
1909	4,264,716	265,000	[a]11,580,000	4,302,000	20,411,716
1910	4,182,730	351,630	[a]8,062,389	3,530,000	16,126,749
1911	4,265,573	313,538	[a]9,139,145	3,135,000	16,853,256
1912	4,904,753	358,401	[a]8,857,797	3,025,000	17,145,951
1913	4,529,529	378,643	[a]8,183,641	2,535 000	15,626,813
1914	4,538,157	597,681	[a]7,895,421	2,733,000	15,764,259
Total	70,450,313	6,008,393	99,055,393	68,642,700	244,156,799

[a] Includes a small production from the Kuskokwim basin.

In 1914 about 32 per cent of the total gold production came from lode mines, compared with 31.6 of gold output credited to lode mines in 1913. In 1912 it was 29 per cent of the total. This indicates a gradual transition from placer to lode mining. In the following table the production of precious metals in 1914 has been distributed as to sources:

Sources of gold, silver, and copper in Alaska, 1914, by kinds of ore.

	Total quantity.	Gold.		Silver.		Copper.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine oz.*				*Pounds.*	
Siliceous ores	1,738,127	235,248.98	$4,863,028	28,254	$15,624		
Copper ores	153,605	8,283.30	171,231	283,355	156,695	21,450,628	$2,852,934
Placers		519,063.75	10,730,000	83,196	46,008		
Total	1,891,732	762,596.03	15,764,259	394,805	218,327	21,450,628	2,852,934

There has been little mining of lead ores as such in Alaska, but some of the Alaska gold ores carry considerable galena. From this source some lead has been recovered. The total Alaska lead output is estimated to be 796 tons, valued at $67,142.

Alaska's auriferous lode mines produced during the year 235,249 fine ounces of gold, valued at $4,863,028, compared with an output of 232,916 fine ounces of gold, valued at $4,814,813, in 1913. These mines made an output of 28,254 fine ounces of silver in 1914, valued at $15,624, and of 30,897 ounces in 1913, valued at $18,662.

Twenty-eight gold lode mines, including several properties which made only small outputs, were operated the whole or a part of the year 1914 in Alaska—2 less than in 1913. Work was also done on many gold prospects, some of which produced a little gold. Of the producing mines 9 were in southeastern Alaska, 8 on Prince William Sound, 4 in Kenai Peninsula, 3 in the Willow Creek district, and 4 in the Fairbanks district. It is estimated that these mines had an output of 1,738,127 tons of ore, compared with 1,614,506 tons in 1913. In 1913 the average value of the gold and silver content for all the ores mined was $2.99 a ton; the average for 1914 was $2.80.

There were 144,625 fine ounces of gold and 18,062 fine ounces of silver recovered by amalgamation and 90,363 ounces of gold and 9,561 ounces of silver recovered by cyanidation in 1914.

Six copper mines were operated in Alaska for the whole or a part of the year 1914, compared with 7 mines in 1913. Of these 2 were in the Ketchikan district, 2 on Prince William Sound, and 2 in the Kotsina-Chitina district. The total production of copper in 1914 is estimated to have been 21,450,628 pounds, valued at $2,852,934, compared with 21,659,958 pounds, valued at $3,357,293, in 1913. Gold valued at $171,231 and silver valued at $156,695 were recovered from the copper ores. It is estimated that in 1914 about 153,605 tons of copper ore were mined, compared with 135,756 tons of copper ore in 1913. The average copper content of the ore was about 6.98 per cent, and the value of the gold and silver recovered about $2.14 to the ton.

The value of the placer gold produced in 1914 is estimated at $10,730,000; that of 1913 was $10,680,000. As compared with 1913 there was a decrease in the placer gold output from Fairbanks, Koyukuk, and Fortymile districts, and an increase from Ruby and Seward Peninsula districts, as well as from some of the smaller camps. It is estimated that about 730 placer mines were operated in 1914—many for only a part of the season—compared with 700 in 1913. A rough estimate indicates that in 1914 about 8,500,000 cubic yards of auriferous gravels were excavated, with an average recovery per cubic yard of $1.26, as against 6,800,000 cubic yards excavated in 1913, with an average recovery of $1.57 per cubic yard.

Forty-two [1] gold dredges were operated for the whole or a part of the mining season in 1914. Of these 39 were located on the Seward Peninsula, 2 in the Iditarod district, and 1 in the Fairbanks district. It is estimated that these dredges handled 4,450,000 cubic yards and made a gold recovery of $2,350,000. The average gold content per cubic yard of the gravels mined is 50 cents. In 1913 there were 36 gold dredges operated, which handled about 4,100,000 cubic yards, having a value of $2,200,000.

Two of the dredges operating on Seward Peninsula are located on Anikovik River in York district, and were used to recover stream tin as well as gold. In addition to these, the dredge on Buck Creek was operated on a tin placer as in previous years.

Some attempts at gold dredging were made in Alaska as early as 1900. This form of mining did not, however, reach a profitable stage until about 1903, when two small dredges were successfully operated in the Seward Peninsula. In 1907 a dredge was installed in the Fortymile district, the first in the Alaska Yukon. Up to the close of 1914 gold to the value of $10,100,894 had been mined in Alaska by dredges. The growth of the gold dredging industry is indicated by the following table:

Value of production of gold by dredge mining in Alaska, 1903–1914.

Year.	Number of dredges operated.	Estimate of value of gold output.
1903	2	$20,000
1904	3	25,000
1905	3	40,000
1906	3	120,000
1907	4	250,000
1908	4	170,901
1909	14	424,993
1910	18	800,000
1911	27	1,500,000
1912	38	2,200,000
1913	36	2,200,000
1914	42	2,350,000
Total		10,100,894

[1] Not including a tin dredge in York district, Seward Peninsula.

REVIEW BY REGIONS.

PACIFIC COAST BELT.

SOUTHEASTERN ALASKA.

There were 9 lode gold mines, 4 placer gold mines, and 2 copper mines operated on a productive basis in southeastern Alaska during 1914. These produced 204,749 ounces of gold, valued at $4,232,538, and 34,376 ounces of silver, valued at $19,009. The copper output can not be published, as it might reveal the production of the individual mines. A total of about 1,712,530 tons of gold ores was hoisted in 1914.

As in previous years, the largest mining developments were those of auriferous lodes near Juneau. Important advances were also made in copper mining in the Ketchikan district, though these were somewhat curtailed in midsummer when the price of copper fell.

Juneau and Berners Bay districts.—Auriferous lode mining was continued in 1914 on a large scale in the Juneau and Berners Bay districts. Seven gold mines were operated, but most of the large developments under way have not yet reached the productive stage. Most of the gold output from the Juneau district came from the four mines of the Treadwell group on Douglas Island. The first section of the mill at the Alaska-Juneau mine was in operation before the close of the year. The stamp mill at the Eagle River mine was operated during the last three months of the year. Some gold was also won at the Jualin incidental to testing the ore. No other properties were on a productive basis, but the large developments at the Alaska-Gastineau and the Alaska-Juneau properties which have been under way for several years were continued, and these mines promise to add very considerably to the gold output in 1915. Among other developments on a considerable scale were those at the Ebner, Salmon Creek, and Kensington properties.

Ketchikan district.—One gold mine and 2 copper mines were on a productive basis in the Ketchikan district during 1914. There was, however, much greater mining activity in the district than is indicated by the number of producing mines, notably so in the development of copper ores. Incidentally some gold and copper was taken from property not here classed as productive mines.

The Rush & Brown mine, near Karta Bay, on Prince of Wales Island, was the only mine in the district which was operated throughout the year. The Jumbo mine, on Hetta Inlet, on the west side of Prince of Wales Island, was operated at its usual capacity until August 31. It was then closed down because of the uncertainty of the copper market.

The Granby Consolidated Mining, Smelting & Power Co. took over in 1913 the Mamie copper mine, located near Hadley, on Prince of Wales Island. In April, 1914, large-scale operations were begun and were continued until September.

The Dunton gold mine,[1] equipped with a 5-stamp mill and located near Hollis on Prince of Wales Island, was operated on a productive basis in 1914. The mill at the Valparaiso gold mine, near Dolomi, Prince of Wales Island, was not operated in 1914, but underground

[1] Also known as Julia or Rodgers mine.

work was continued. Until the war broke out the Alaska Venture Syndicate, an English company, continued work on the Old Glory claims, near Smuggler Cove, on mainland 30 miles northwest of Ketchikan.

Other districts.—The Chichagof gold mine, in the Sitka district, was operated throughout the year. Five stamps and a 12-foot tube mill were added to the equipment, making 25 stamps in all. Three hydraulic plants were operated or in process of construction in 1914 in the Porcupine district, which is tributary to Haines, on Lynn Canal, and another plant is in course of construction on Salmon River, in the same region.

YAKATAGA DISTRICT.

In 1914 the hydraulic placer mine on White River, in the Yakataga district, was operated throughout the season. In addition to this, there was some mining of beach placers at Yakataga, but the value of the entire output from beach mining did not exceed $3,000 to $4,000.

PRINCE WILLIAM SOUND.

Two copper mines and 8 gold lode mines were operated in Prince William Sound region in 1914. The value of the total mineral production of the region in 1914 was $1,198,742, compared with $1,327,950 in 1913. This decrease is due to the fall in price of copper.

The Beatson Bonanza and the Ellamar copper mines continued throughout the year on their normal shipping basis. An aerial tram was nearly completed, and considerable underground work was done on the Midas copper mine by the Granby Co., near Valdez, before the decline in value of copper led to the closing of the plant.

The Cliff gold mine, near Valdez, was operated until the early summer. A mill was installed during the summer on the Ramsey & Rutherford property, in the same district, and some gold was produced on this as well as on the Cameron & Johnson, Gold King, Mountain King, and several other properties. The mill at the Granite mine, in the Port Wells district, was operated for practically the entire year. A small plant was installed in the fall on the Gold Eagle property, in the same district.

SOUTHWESTERN ALASKA.

Work was continued at the Amok gold lode mine, on the west side of Kodiak Island, but so far as known this property was not on a productive basis. Some work was done by F. R. Brennan on an auriferous quartz vein on the north side of Viekoda Bay, locally known as Little Uganik Bay. The only other mining on Kodiak Island consisted of some small operations on beach placers. Some beach mining also continued at Popof Island, near Unga. The total gold production in 1914 from beach mines at Kodiak and other places in southwestern Alaska is estimated to have a value of about $4,000. Plans are being made to construct a cyanide plant to work over the tailings of the Apollo mine, on Unga Island. In the Iliamna and Mulchatna regions there was no production, but developments were continued on some copper and gold lodes.

COPPER RIVER AND COOK INLET REGIONS.

COPPER RIVER REGION.

Mining in the Copper River region includes the development of copper mines in the Kotsina-Chitina copper belt and placer mining in the Nizina and the Chistochina districts. There is also a little placer mining in the Bremner River region and in the Nelchina district, and some lode prospecting in various parts of the Copper River basin.

In the Kotsina-Chitina belt there were two productive copper mines—the Kennicott-Bonanza and the Mother Lode—and some copper was also shipped from the Kennicott Jumbo property. Three hydraulic plants were operated in the Nizina district in 1914, and there were also some smaller operations in the same field. A little placer mining was also done in the Bremner River basin and in other parts of lower Copper River region. The placers discovered in the basin of Nelchina River, tributary to Tazlina River, in 1913, have not proved either rich or extensive. Auriferous gravels were found on several creeks, but only those on Albert Creek have proved rich enough to exploit, and the output of gold so far has been insignificant.

Ten placer mines were operated in the Chistochina district in 1914. Two hydraulic plants were operated on Slate Creek; the other operations on that creek were by pick and shovel methods. Some preliminary work was done looking to the installation of a hydraulic plant on Hidden Treasure Creek.

KENAI PENINSULA.

The value of the total gold production of the Kenai Peninsula in 1914 is estimated to be $70,000, compared with about $50,000 in 1913. Though there was much prospecting and initial development work looking toward lode and placer mine development in the peninsula, no important advances were made. Lode mining continued during the year on only a very small scale, but there was some improvement in the placer mining industry. It seems probable that some attempt is soon to be made to develop some of the larger bodies of auriferous gravels whose low-grade tenor has not permitted of profitable exploitation under present methods of operation. Now that the northeastern part of the peninsula is to be served by a Government railroad, one can look forward with confidence to a more prosperous mining industry. About 20 placer mines and 4 lode mines were operated during the summer months on Kenai Peninsula. As the total value of the output of the lode mines, including some prospects which are not included above, was less than $26,000, it can be seen that they were all small operations.

SUSITNA-MATANUSKA REGION.

The developed mineral resources of the Susitna-Matanuska region include the Willow Creek gold lode district, the Yentna and Valdez Creek placer districts, and the Matanuska coal field. Besides these, a little placer mining has been done on Willow Creek and on tributaries of upper Chickaloon Creek. Discoveries have also been

reported of large low-grade lode deposits in the Broad Pass region of the upper Susitna, but authentic information in regard to these is lacking. The Susitna and Broad Pass route has been selected for the Government railroad from Seward to Fairbanks. The assurance of railway communication will give a strong impetus to prospecting in this field, a condition which has to some extent been anticipated by the developments made in 1914.

Willow Creek district.—Three lode mines operated in the Willow Creek district in 1914 milled 10,110 tons of ore, which yielded $297,184 in gold. One hydraulic placer mine was also operated at the mouth of Grubstake Gulch, in this district, from June 22 to September 15. Some placer ground on Willow Creek was also prospected by another company and incidentally some gold was recovered.

Yentna district.—The season of 1914 was not favorable to placer mining in the Yentna district on account of low water during July. It is estimated that about 25 plants were operated during the summer. Unfortunately, many of the operators did not report gold output, so that reliable figures of production are not available. It is estimated, however, that the total output in 1914 had a value of about $50,000.

Valdez Creek district.—Developments continued on Valdez Creek, a tributary of the headwaters of the Susitna which carries valuable gold placers. Up to a few years ago placer mining in this field was confined to small operations. In the fall of 1914 the installation of a large hydraulic plant on this creek was completed and some sluicing was done. There were also a few other small operations in this district.

YUKON AND KUSKOKWIM BASINS.

YUKON BASIN.

PRODUCTION.

The value of the gold output of the Alaska Yukon districts in 1914 is estimated to have been $7,795,421, compared with an output of $8,130,000 in 1913. It is estimated that about 500 placer mines were operated in the Yukon camps in 1914. Only 4 lode mines were operated on a productive basis in the Yukon basin in 1914, and these were all in the Fairbanks district. There were a number of other lode properties that produced some gold incidental to development.

Fairbanks district.—It is estimated that about 125 placer mines were operated in the Fairbanks district during the summer of 1914 and about 50 during the previous winter. These produced gold to the value of about $2,500,000, compared with a value of about $3,300,000 for the placer gold output of 1913. Four quartz mines were operated in the district in 1914, and these, with the output of some minor operations, produced gold to the value of $225,421. Fourteen lode mines and prospects operating in 1913 produced gold to the value of $350,000. The decline in mining was due to high cost of operation and not to exhaustion of deposits. One dredge was operated on Fairbanks Creek during the season of 1914. About half the gold output of the year was taken from the placers of Goldstream and Cleary creeks.

Iditarod district.—The value of the gold production from the Iditarod district in 1914 is estimated to be $2,060,000, compared with $1,860,000 in 1913. Much the larger part of the Iditarod output is

taken out by a few large plants, and only about 15 mines were worked in 1914. The largest operations are those of the two dredges, one on Flat Creek and the other, which began work in the season of 1914, on Otter Creek. As in previous years, most of the gold output came from Flat and Otter creeks.

Innoko district.—The Innoko district is estimated to have produced gold to the value of $200,000 in 1914, and $280,000 in 1913. This was produced by 26 mines. All of this work, except a little winter drift mining on Ophir and Little creeks, was by open cut. The producing creeks are Ophir, Spruce, Little, Ganes, and Yankee. It is reported also that considerable work was done on Cripple Creek, which is located about 30 miles northeast of Ophir.

Ruby district.—It is estimated that the Ruby district, including the tributaries to the north, produced about $1,000,000 in 1914, compared with $785,000 in 1913. About 55 different mines were operated during the summer, and probably about 20 were worked in the winter. The largest placer mine operations during the summer of 1914 were on Long Creek and its tributaries. There was also considerable mining at Poorman Creek and vicinity, in the southern part of the Ruby district.

Hot Springs district.—The gold placers of the Hot Springs district produced gold to the value of about $750,000, as compared with $400,000 in 1913. About 40 mines large and small were operated in Hot Springs district in 1914, employing some 300 men. The largest operations of the district were in the Sullivan Creek basin. Some stream tin was recovered incidental to gold placer mining.

Koyukuk district.—It is estimated that the Koyukuk district produced gold to the value of $260,000 in 1914; in 1913 the output was about $400,000. The decrease was in part due to lack of water, but largely because in 1913 one or two deep mines on Hammond River worked on very rich ground and thereby abnormally increased the total output. So far as can be learned, the value of the annual gold output from the Koyukuk district has for a number of years been from $200,000 to $300,000. It is estimated that during 1914 about 30 different mines were worked in the district. These were about equally divided between the winter and the summer seasons, but about four-fifths of the gold was taken out during the winter, and, indeed, most of this was won from the deep Hammond River placers.

Small operations continued in the Indian River district, lying in the lower Koyukuk basin. It is estimated that six or eight mines were operated during the summer, with a gold output valued at about $25,000.

Chisana district.—The greater number of the stampeders who went to the Chisana district in 1913–14 returned without realizing their expectations in the new camp. Nevertheless, some rich placer ground has been found in this district, though the total bulk of auriferous gravels so far developed is not large. The total gold output from the district in 1914 had a value of about $250,000. It came chiefly from Bonanza Creek, but there was also a considerable output from Little Eldorado and Skookum creeks. Twenty-two mines were operated in this district during the summer of 1914.

Circle precinct.—The Circle precinct includes the Birch Creek district, as well as the placers of Woodchopper Creek and of Beaver

Creek basin. It is estimated that gold to the value of $225,000 was produced in 1914, compared with $175,000 in 1913. About 46 mines were operated in winter and 53 plants in summer. Nearly three-fourths of the gold produced was taken out in the summer. About half the gold produced was taken from the mines on Mammoth and Mastodon creeks.

In the Woodchopper Creek region about 10 mines were operated during the summer of 1914, and the same number in the preceding winter. Most of these mines were on Coal Creek, a southerly tributary of the Yukon, 60 miles above Circle.

Fortymile district.—The possiblities of large mining developments in the Fortymile district are now under investigation, but meanwhile actual mining is on the decrease. In 1914 the value of gold output from the Fortymile district was about $60,000, compared with $100,000 in 1913. Nearly all the operations in 1914 were on a small scale. Probably about 25 claims were worked during the summer, and some winter work was also done.

Eagle precinct.—The Eagle precinct includes the gold placers of American Creek and Seventymile River and of some smaller streams tributary to the Yukon from the south. The value of the gold output from American Creek in 1914 is estimated to have been $50,000, or about the same as the value of the output in 1913. It is estimated that about 20 mines were operated during the year. There was practically no winter work.

Rampart district.—The usual small operations were continued in the Rampart district in 1914. About 10 mines were operated in the summer and 6 in the winter. The value of the total gold output was about $30,000. Hunter Creek led the others in scale of operations and in output. Little Minook Creek was the second largest producer.

Smaller Yukon districts.—Placer mining in the Chandalar district during 1914 was confined to some small operations on Big, St. Marys, and Squaw creeks. Three mines were operated. No important developments of the auriferous lodes have been reported. Productive mining operations in the Bonnifield district were on the same scale as in previous years. It is estimated that 15 mines operated and recovered gold to the value of $30,000.

There were no new productive developments in the Kantishna district. The gold output in 1914 was estimated to have a value of $20,000, and was taken from 10 mines. Both the Kantishna and the Bonnifield districts showed the stimulating effects of the proposed railroad. The Government railroad will pass along the western margin of the Bonnifield district and about 60 miles from the Kantishna district. There was therefore far more prospecting in both these districts than in the previous years.

In 1913 some placer gold was found on Wilson Creek, a northern tributary of the lower Yukon. The first discovery of placer gold in the district was made in July, 1913. In 1914 three plants were engaged in mining.

KUSKOKWIM BASIN.

The total gold output of the Kuskokwim basin in 1914 was valued at $110,000; that of 1913 was probably about $50,000. It is estimated that 25 plants were operated in 1914. The largest mining

developments in the Kuskokwim basin are those tributary to McGrath, located at the mouth of Takotna River. One large plant was operated. On Candle Creek there is in operation an open-cut mine, the gravels of which are 9 feet deep. A steam bucket hoist is used, which elevates the gravels to the sluice box. A churn drill is being used to prospect the deeper placers on the same property. Three smaller plants were operated on Moore Creek.

Mining was also done in the headwater region of Crooked Creek, tributary to the Kuskokwim near Georgetown. Mining was also continued on Bear Creek, and some of its tributaries in the Tuluksak basin; on Canyon Creek, flowing into Kwethluk River; on Marvel Creek, of the Aniak River basin; on Rainy and Kapon creeks, confluents of Eek River; and on Butte Creek, a tributary of Aalalik River.

Lodes, including deposits carrying gold, copper, and cinnabar, have attracted some attention in the Kuskokwim basin, in spite of the present difficulties of transportation. There has been a small production of quicksilver from the Parks claim, a cinnabar prospect located on the north bank of the Kuskokwim about 21 miles above Georgetown. Other cinnabar deposits in this region have been more or less prospected.

SEWARD PENINSULA AND NORTHWESTERN ALASKA.

SEWARD PENINSULA.

The value of the gold output from Seward Peninsula in 1914 was about $2,700,000; that of 1913 was $2,500,000. Thirty-nine gold dredges were operated in Seward Peninsula in 1914. Of these, two were working in the York district on placer ground which carried both gold and tin. In addition to these there was a placer tin dredge in the York district. The 39 gold dredges were not all worked the full season, for some were not completed in time. It is estimated that dredges recovered gold to the value of $1,450,000. The output was curtailed because the dredging season was unusually short.

It is estimated that 70 other placer mines in addition to the dredges were operated on the peninsula in 1914 and produced gold to the value of $1,250,000.

KOBUK REGION.

Placer mining in a small way was continued in the Kobuk region during 1914. In the Squirrel River district three claims were worked in the winter and five in the summer. Some mining was also done in the Shungnak district. The total output of gold from the Kobuk region in 1914 is estimated to have a value of $35,000.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES IN 1914.

(MINES REPORT.)

By J. P. Dunlop.

INTRODUCTION.

In the following pages is given a brief review of the gold, silver, copper, lead, and zinc mining industries in the Eastern or Appalachian States for the calendar year 1914. The area covered lies, for the greater part, immediately east of the Blue Ridge and its extensions, and is mainly coincident with the broad belt of old metamorphic and associated igneous rocks extending southwestward from Canada to Alabama. The zinc-lead belt of southwestern Virginia and eastern Tennessee, however, whose rocks are mainly Cambrian and Ordovician limestone and conglomerate, lies to the west of this great belt.

References have been given in previous reports to the most important papers on these mines in the Eastern States, and the geologic relations have, in most cases, been briefly described. At the end of the present report are given lists of the most important Survey publications on gold, silver, copper, lead, and zinc, of interest to those mining these metals in the Eastern States.

HISTORICAL REVIEW OF THE PRODUCTION OF GOLD IN THE SOUTHERN APPALACHIAN STATES.

Notwithstanding the relatively small quantity of gold produced in the southern Appalachian States in recent years it is of interest to recall that the first gold mining in the United States was not done in the Western States and that prior to the discovery of gold in California the Southern States had yielded over $12,000,000.

As early as the year 1516 a small quantity of gold is said to have been obtained by European explorers from the natives of Florida.[1] There is, however, no record of any mining at that time, and it is probable that the gold, which was used for ornaments, was picked up by the Indians in streams or after heavy rains and not obtained by panning or other methods involving labor or even primitive washing equipment. Even within the last few years small nuggets have been picked up by farm hands and others in localities where no regular mining is done. Thomas Jefferson[2] describes a lump of ore

[1] Becker, G. F., Reconnaissance of the gold fields of the southern Appalachians: U. S. Geol. Survey Mineral Resources, 1894, pp. 10–12, 1895.

[2] Notes on Virginia, completed in 1782 and a few copies printed.

that was found on the Rappahannock in Virginia in 1782, and that yielded 17 pennyweights of gold. A nugget of gold was found in North Carolina at the Reed mine in Cabarrus County in 1799, but it seems not to have been recognized at first as gold and no mining was done there for several years, or until about 1804. Gold was also discovered in Montgomery County, N. C., soon afterward, and in Anson County in 1829. From 1804 to 1825 practically all the gold produced in the United States came from North Carolina and the total amount, so far as the Mint records show, was only $110,000, which was all obtained from surface placers. In 1825 gold-bearing ore in place was found in Montgomery County, N. C., and soon afterward quartz veins were found in Mecklenburg County. The production from these new mines was so large that development work was extended to Guilford, Davidson, Union, Rowan, and other counties. The estimated production of gold in North Carolina increased from $46,000 in 1828 to $134,000 in 1829 and to $475,000 in 1833. A curious bit of history affecting the accuracy of the statistics is the coinage of gold by one Bechtler in North Carolina about 1833 and for years afterward. It is said that for some time these coins and Mexican silver constituted the chief currency of large districts. To insure their reception the Bechtler coins were made slightly overweight, which, of course, led to their rapid disappearance.[1] The largest yield recorded in any year was that of $845,793 in 1849, and the estimated total output of gold from North Carolina to the end of 1914 is $23,416,357, or nearly one-half of the entire yield from the southern Appalachian States.

In 1829 gold was discovered in Georgia in Habersham County, and explorations were soon extended to Hall and Carroll counties and to the Nacoochee Valley region in White County and the Dahlonega district in Lumpkin County.[2] Many of the placer deposits were rich and easily worked, so that active mining followed the discoveries. The greater part of the gold output of early years was derived from placer mining, and the production from Lumpkin County has probably been greater than from any other county. The most productive period was between the years 1838 and 1848, when the estimated yield from Georgia was about $3,582,000, or about one-half of the total gold output of the United States during that time. A branch of the United States Mint was established at Dahlonega in 1838, which coined $6,115,569 in the period 1838–1861. The total gold production of Georgia for the period 1829–1914 is estimated at $17,752,627. The yearly output has not amounted to as much as $200,000 since 1883 and has not been as much as $100,000 in any year since 1902.

There does not appear to be any record of the first mining in Alabama, but it probably dates from about 1830 or shortly after the gold excitement commenced in Georgia. The estimated production up to 1879 was $365,300, and the yearly output from 1880 to 1903 varied from $1,000 to $8,000 a year. Alabama, unlike most other Southern States, has made its greatest production in recent years from 1904 to 1910, from deep mines, including the Hog Mountain in Tallapoosa County and the Storey in Talladega County. The estimated total yield of gold from Alabama to the end of 1914 is $749,384.

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[1] Becker, G. F., op. cit., p. 10.
[2] Jones, S. F., Gold deposits of Georgia. Georgia Geol. Survey Bull. 19, p. 17, 1909.

The earliest report of the discovery of gold in Maryland is found in the proceedings of the American Philosophical Society, page 85, 1849, wherein mention is made of the occurrence of quartz veins carrying gold, on the Samuel Ellicott farm in Montgomery County. If any mining was done the output must have been small, for the total estimated output up to the year 1879 was only $2,500. The total production of gold from Maryland mines to the end of 1914 is estimated to have been $71,339. Most of the yield has been derived from mines in Montgomery County near Great Falls, but part of the production has come from the smelting of copper ores from Frederick County. The gold mines of Montgomery County, Md., have been described by Emmons.[1]

Gold was first sent to the Mint from South Carolina in 1829, and from mines in Chesterfield and Lancaster counties in 1830. The Brewer mine in Chesterfield County was one of the most important of the early properties and has probably produced several hundred thousand dollars. The gold output of South Carolina (as estimated by the United States Mint) from 1829 to 1853 amounted to $1,085,491 and the yield only exceeded $100,000 in one year, 1852. The Dorn mine, in the Abbeville district, was one of the most active and productive mines in the South in 1852 and 1853. In South Carolina since 1890 the yield has frequently exceeded $100,000 a year, and the greatest output was in 1899, when it was over $160,000. The Haile mine in Lancaster County has yielded more gold than any other mine in the Southern States. The upper oxidized portions of the ore bodies were rich and the mine has been worked more or less continuously since 1830. The gold from ore from the Haile mine was obtained by stamp milling and amalgamating in early years. When the upper oxidized ore bodies had been exhausted, Adolph Thies, the manager of the property, devised a method of concentration, roasting, and chlorination, by which the low-grade sulphide ore bodies were treated cheaply and efficiently. Spilsbury [2] gives the production up to the end of 1883 as more than $1,250,000, and it has been the largest producer in the State since that year, so that its total production is probably more than $3,000,000 out of a total of $5,176,237, the estimated total gold production of the State of South Carolina to the end of 1914. The mine was visited and described by Graton.[3]

The estimated production of gold from Tennessee to the end of 1914 is $230,217. The yield has seldom exceeded $10,000 in any one year and in many years has been only a few hundred dollars. Of the total, about $155,000 was produced between 1831 (when the Mint has the first recorded output) and 1879. From 1880 to 1903 the annual yield of gold was usually less than $1,000. Since 1904 practically all the gold has been obtained from the electrolytic refining of copper from the mines in Polk County. Much of the gold produced prior to 1903 or 1904 came from placer mining in Monroe County. These placer mines, however, have not reported any output for several years.

After the date of Thomas Jefferson's note, referring to the first recorded discovery of gold in Virginia in 1779, the next discovery of gold seems to have been in 1829, when the mint credits Virginia with

[1] Emmons, S. F., Am. Inst. Min. Eng. Trans., vol. 18, pp. 391–412, 1890.
[2] Am. Inst. Min. Eng. Trans., vol. 1, p. 60.
[3] Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 75–87, 1906.

a gold yield of $2,500. Prof. Silliman[1] visited the mines, which were mainly in Goochland, Louisa, and Culpeper counties, in 1836. The mines apparently were worked steadily, as the mint estimates credit Virginia with a yearly production varying from $24,000 to more than $100,000 up to the year 1853 and with a total production of $3,091,700 for the period 1829 to 1879. Since 1880 the yearly output has seldom been as much as $10,000 a year, and the gold mines in Goochland and Fluvanna counties have been operated intermittently. A considerable portion of the gold production credited to Virginia since 1904 has been derived from copper ores shipped from the Cabin Branch pyrite mine in Prince William County.

The estimated total gold output from Virginia to the end of the year 1914 is $3,293,407.

The following tables give the total production of gold in the southern Appalachian States from the discovery of the metal to the end of 1914 and the yearly output of each State, so far as records are available. The figures given are those of the Bureau of the Mint for the period 1799 to 1904 and those of the United States Geological Survey for the period 1905 to 1914.

The total yield of gold from 1799 to the end of 1914 is $50,689,568, as shown in the following table:

Value of estimated production of gold in the southern Appalachian States, 1799–1914, by States.

Alabama	$749,384
Georgia	17,752,627
Maryland	71,339
North Carolina	23,416,357
South Carolina	5,176,237
Tennessee	230,217
Virginia	3,293,407
Total	50,689,568

Estimated production of gold in Alabama in 1831–1879 and annually since 1880.

Year.	Value.	Year.	Value.	Year.	Value.	Year.	Value.
1830-1879	$365,300	1889	$2,639	1899	$4,766	1909	$29,239
1880	1,000	1890	2,170	1900	2,618	1910	33,533
1881	1,000	1891	2,245	1901	3,773	1911	18,916
1882	3,500	1892	2,419	1902	2,938	1912	16,724
1883	6,000	1893	6,362	1903	4,894	1913	11,094
1884	5,000	1894	4,092	1904	29,288	1914	11,970
1885	6,000	1895	4,635	1905	41,530		
1886	4,000	1896	6,495	1906	24,921	Total	749,384
1887	2,500	1897	8,455	1907	25,982		
1888	5,600	1898	6,578	1908	41,208		

Estimated production of gold in Georgia in 1830–1879 and annually since 1880.

Year.	Value.	Year.	Value.	Year.	Value.	Year.	Value.
1830-1879	$14,180,500	1889	$108,069	1899	$117,106	1909	$60,620
1880	120,000	1890	101,318	1900	124,528	1910	35,602
1881	125,000	1891	80,622	1901	147,583	1911	35,070
1882	250,000	1892	95,251	1902	106,766	1912	14,360
1883	200,000	1893	100,375	1903	66,541	1913	15,108
1884	137,000	1894	99,095	1904	96,929	1914	16,270
1885	136,000	1895	127,942	1905	96,910		
1886	153,500	1896	149,288	1906	31,050	Total	17,752,627
1887	110,500	1897	154,223	1907	64,808		
1888	104,500	1898	133,989	1908	56,207		

[1] Am. Jour. Sci., vol. 32, p. 98, 1837.

Estimated production of gold in Maryland in 1867–1879 and annually since 1880.

Year.	Value.	Year.	Value.	Year.	Value.	Year.	Value.
1867–1879...	$2,500	1889.....	$3,500	1899.....	$1,173	1909.....	.....
1880.....	250	1890.....	16,962	1900.....	392	1910.....	.....
1881.....	500	1891.....	11,264	1901.....	139	1911.....	.....
1882.....	1,000	1892.....	1,000	1902.....	2,719	1912.....	.....
1883.....	500	1893.....	114	1903.....	632	1913.....	.....
1884.....	500	1894.....	978	1904.....	2,379	1914.....	$225
1885.....	2,000	1895.....	499	1905.....	14,821		
1886.....	1,000	1896.....	1,038	1906.....	.....	Total..	71,339
1887.....	500	1897.....	364	1907.....	.....		
1888.....	3,500	1898.....	890	1908.....	.....		

Estimated production of gold in North Carolina in 1799–1879 and annually since 1880.

Year.	Value.	Year.	Value.	Year.	Value.	Year.	Value.
1799–1879...	$19,659,600	1889.....	$150,174	1899.....	$40,713	1909.....	$40,230
1880.....	95,000	1890.....	126,397	1900.....	44,653	1910.....	68,045
1881.....	115,000	1891.....	101,477	1901.....	60,411	1911.....	70,282
1882.....	215,000	1892.....	90,196	1902.....	93,650	1912.....	166,614
1883.....	170,000	1893.....	70,505	1903.....	105,603	1913.....	126,448
1884.....	160,500	1894.....	52,927	1904.....	123,924	1914.....	131,141
1885.....	155,000	1895.....	68,476	1905.....	125,685		
1886.....	178,000	1896.....	51,381	1906.....	82,131	Total..	23,416,357
1887.....	230,000	1897.....	38,646	1907.....	82,193		
1888.....	139,500	1898.....	89,960	1908.....	97,495		

Estimated production of gold in South Carolina in 1829–1879 and annually since 1880.

Year.	Value.	Year.	Value.	Year.	Value.	Year.	Value.
1829–1879...	$2,587,600	1889.....	$47,085	1899.....	$160,312	1909.....	$11,053
1880.....	15,000	1890.....	100,294	1900.....	122,657	1910.....	38,324
1881.....	40,000	1891.....	130,149	1901.....	127,304	1911.....	20,408
1882.....	25,000	1892.....	123,881	1902.....	154,680	1912.....	16,915
1883.....	57,000	1893.....	127,991	1903.....	107,883	1913.....	4,881
1884.....	57,500	1894.....	98,763	1904.....	121,798	1914.....	7,360
1885.....	43,000	1895.....	127,819	1905.....	95,111		
1886.....	38,000	1896.....	100,323	1906.....	78,959	Total..	5,176,237
1887.....	50,500	1897.....	85,609	1907.....	54,765		
1888.....	39,200	1898.....	105,398	1908.....	53,715		

Estimated production of gold in Tennessee in 1831–1879 and annually since 1880.

Year.	Value.	Year.	Value.	Year.	Value.	Year.	Value.
1831–1879...	$155,300	1889.....	$750	1899.....	$176	1909.....	$4,118
1880.....	1,500	1890.....	1,001	1900.....	310	1910.....	3,113
1881.....	1,750	1891.....	519	1901.....	255	1911.....	11,621
1882.....	250	1892.....	1,006	1902.....	142	1912.....	8,265
1883.....	750	1893.....	250	1903.....	58	1913.....	7,595
1884.....	300	1894.....	329	1904.....	4,331	1914.....	6,194
1885.....	300	1895.....	334	1905.....	4,362		
1886.....	500	1896.....	584	1906.....	4,838	Total..	230,217
1887.....	500	1897.....	145	1907.....	3,825		
1888.....	1,100	1898.....	147	1908.....	3,699		

Estimated production of gold in Virginia in 1828–1879 and annually since 1880.

Year.	Value.	Year.	Value.	Year.	Value.	Year.	Value.
1828–1879...	$3,091,700	1889.....	$4,113	1899.....	$7,729	1909.....	$3,750
1880.....	11,500	1890.....	6,496	1900.....	3,558	1910.....	888
1881.....	10,000	1891.....	6,699	1901.....	6,465	1911.....	3,064
1882.....	15,000	1892.....	5,002	1902.....	4,295	1912.....	218
1883.....	7,000	1893.....	6,190	1903.....	4,465	1913.....	604
1884.....	2,500	1894.....	7,643	1904.....	3,853	1914.....	429
1885.....	3,500	1895.....	6,303	1905.....	4,982		
1886.....	4,000	1896.....	4,435	1906.....	14,832	Total..	3,293,407
1887.....	14,600	1897.....	4,280	1907.....	8,288		
1888.....	7,500	1898.....	5,075	1908.....	2,451		

MINE PRODUCTION.

The total value of the mine output of gold, silver, copper, lead, and zinc in the Eastern or Appalachian States in 1914 was $11,437,707, against a corresponding value of $12,413,396 in 1913, a decrease of $975,689, due mainly to the lower average price of copper and of zinc in 1914.

The following table shows concisely the quantity of ore sold or treated and the recoverable metals of the Eastern or Appalachian States from 1906 to 1914, inclusive:

Ore treated and mine production of metals in the Appalachian States, 1906–1914.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1906	979,881	$236,731	89,088	18,849,605	9,750	141,282,000	$12,572,454
1907	906,103	239,902	85,661	20,307,180	140,599	119,176,000	11,396,153
1908	1,116,392	259,143	66,170	19,880,894	76,190	136,429,800	9,333,902
1909	1,322,849	155,940	66,912	20,354,225	.....	166,328,859	11,818,531
1910	1,252,231	185,522	91,595	17,923,412	198,850	140,875,886	10,127,304
1911	1,258,144	159,370	108,105	19,605,386	834,742	159,351,558	11,787,942
1912	1,361,734	222,496	96,523	19,265,945	561,026	144,699,863	13,470,276
1913	1,603,539	165,733	111,205	19,964,729	1,632,000	160,966,960	12,413,396
1914	1,842,890	173,589	100,727	19,555,362	254,000	169,716,954	11,437,707
Increase (+) or decrease (−) in 1914	+239,351	+7,856	−10,487	−409,367	−1,378,000	+8,749,994	−975,689

GOLD.

The total production of gold in the Eastern States in 1914 was 8,397.36 fine ounces, valued at $173,589, an increase of 380.03 ounces in quantity and of $7,856 in value. The placers yielded 904.56 ounces, against 733.65 ounces in 1913; the siliceous or gold quartz ores 7,165.59 ounces, against 6,892.09 ounces in 1913; the copper ores 327.21 ounces, against 391.59 ounces in 1913; the lead and lead-zinc ores produced no gold in 1914.

The output of gold from all sources, therefore, increased 380.03 ounces. There were small increases in Alabama, Georgia, Maryland, North Carolina, and South Carolina, and small decreases in Tennessee and Virginia.

SILVER.

The production of silver in the Eastern States in 1914 was 100,727 fine ounces, valued at $55,702, a decrease of 10,487 fine ounces in quantity and of $11,471 in value from the corresponding production for 1913. The silver yield was a by-product from the refining of gold and copper produced in 1914, the bulk of it from the copper ores of the Ducktown district in Tennessee, where there was a decrease of 10,703 ounces from the output for 1913. The copper ores of Maryland, North Carolina, and Virginia yielded small increases of silver, that of Virginia amounting to about 550 ounces more than in 1913. There was no production reported of argentiferous lead-zinc ores from North Carolina in 1914, but more than 1,500 ounces of silver were derived from the gold ores of that State.

Mine production of gold and silver in Eastern States in 1914, by States, in fine ounces.

State.	Gold.		Silver.		Increase (+) or decrease (−) in value compared with 1913.	
	Quantity.	Value.	Quantity.	Value.	Gold.	Silver.
Alabama	579.05	$11,970	199	$110	+ $876	+ $39
Georgia	787.06	16,270	67	37	+1,162	− 8
Maryland and Pennsylvania	10.88	225	44	24	+ 225	+ 24
North Carolina	6,343.94	131,141	1,524	843	+4,693	− 252
South Carolina	356.04	7,360	33	18	+2,479	− 6
Tennessee	299.63	6,194	97,402	53,864	−1,401	−11,431
Vermont					− 3	− 63
Virginia	20.76	429	1,458	806	− 175	+ 226
Total	8,397.36	173,589	100,727	55,702		
Increase (+) or decrease (−) in 1914	+380.03	+7,856	−10,487	−11,471	−7,856	−11,471

Source of gold and silver in Eastern States in 1914, by States, in fine ounces.

State.	Gold.			Silver.		
	Placers.	Dry or siliceous ores.	Copper ores.	Placers.	Dry or siliceous ores.	Copper ores.
Alabama	24.19	554.86			199	
Georgia	534.20	252.86		29	38	
Maryland and Pennsylvania		10.64	24			44
North Carolina	324.45	6,012.91	6.58	33	1,467	24
South Carolina	21.72	334.32			33	
Tennessee			299.63			97,402
Virginia			20.76			1,458
Total, 1914	904.56	7,165.59	327.21	62	1,737	98,928
Total, 1913	733.65	6,892.09	391.59	57	1,987	109,170

COPPER.

The copper output of the Eastern States was 19,555,362 pounds in 1914, valued at $2,600,863, against 19,964,729 pounds, valued at $3,094,533, in 1913. These figures show a decrease for 1914 of 409,367 pounds in quantity and of $493,670 in value. The great bulk of the output was, as usual, from the pyrite copper ores of the well-known Ducktown district of eastern Tennessee, the remainder coming chiefly from the copper-bearing magnetic iron ores of Cornwall, Pa., from copper residues of North Carolina, and from the pyrite ores and mine waters of Virginia.

LEAD.

The production of lead in the Eastern States in 1914 was 254,000 pounds, valued at $9,906, a decrease of 1,378,000 pounds in quantity and of $61,902 in value. The production was all from southwestern Virginia in both 1913 and 1914.

ZINC.

The recoverable zinc output of the Eastern States in 1914 was 169,716,954 pounds, valued at $8,597,647, an increase of 8,749,994 pounds in quantity and a decrease of $416,502 in value, compared with the production of 1913. About seven-eighths of the production was from New Jersey and nearly all the remainder from eastern Tennessee. The yield from Virginia ores was small, and the zinc from New Hampshire was derived from concentrates made in previous years. The value of the zinc output of the Eastern States was $5,757,587 more than the value of their combined production of gold, silver, copper, and lead in 1914.

Mine production of copper, lead, and zinc in Eastern States in 1914, by States, in pounds.

State.	Copper.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New Jersey	.....	.....	.....	.....	148,506,500	$7,515,914
New Hampshire	.....	.....	.....	.....	12,454	635
Maryland and Pennsylvania	658,264	$87,549	.....	.....	.....	.....
North Carolina	20,434	2,718	.....	.....	.....	.....
Tennessee	18,737,656	2,492,108	.....	.....	20,850,000	1,063,350
Virginia	139,008	18,488	254,000	$9,906	348,000	17,748
Total	19,555,362	2,600,863	254,000	9,906	169,716,954	8,597,647
Increase (+) or decrease (−) in 1914	−409,367	−493,670	−1,378,000	−61,902	+8,749,994	−416,502

NUMBER OF MINES AND OUTPUT OF ORE.

There were 81 producing mines reported to the Survey in 1914, of which 36 were deep and 45 were placer properties. The latter are mostly small, many of them yielding only nominal and occasional outputs of gold. In 1913 there were 90 reported producers, of which 42 were deep mines. Of the 36 deep mines in 1914, those producing copper numbered 7, those producing zinc (and in one case lead also) numbered 7, and the remainder were gold mines. The largest number of operating properties in 1914 were in Georgia, where there were 26 gold placers and 11 deep mines, or 37 in all. In 1914 North Carolina had 21 producers, of which 12 were placers.

The total quantity of ore sold or treated in 1914 was 1,842,890 short tons, of which 33,812 tons were gold-quartz ores, 907,894 tons were copper and copper-bearing iron ores, and 901,184 tons were zinc ores (including a small quantity of lead-zinc material). In 1913 the total quantity of ores sold or treated was 1,603,539 short tons, of which 18,883 tons were gold-quartz, 892,308 were copper and copper-bearing iron ores, and 692,348 were zinc and lead-zinc ores. There was therefore a considerable increase in total quantity in 1914 of all classes of ores, and particularly of zinc ores. The gold-quartz ores were mainly from South Carolina, North Carolina, and Alabama in 1914, and the bulk of the copper ores were from the Ducktown district of Tennessee, the remainder being chiefly the copper-bearing magnetites of the Cornwall mines in Pennsylvania. More than half of the zinc ores were from New Jersey, but there was a large increase from Tennessee, where the production of zinc ores more than doubled.

The gold-quartz ores and tailings yielded an average precious-metal recovery per ton of $4.41 in 1914, against $7.76 in 1913. The average yield in North Carolina was $6.43 in 1914, $10.83 in 1913, and $10.62 in 1912. The copper ores averaged a recovery of $0.07 in precious metals, against $0.08 in 1913, and 21.5 pounds of copper per ton in 1914, against 22.4 pounds in 1913. The zinc ores yielded no precious metal recoveries, but 188.3 pounds of zinc per ton in 1914, against 232.5 pounds in 1913. This decrease in average recovery from ore was due to the increased quantity of sphalerite ore mined and concentrated at the Mascot mine in Tennessee.

Total number of producing mines, ore production, and average value of gold and silver per ton in Eastern States in 1914, by States, in short tons.

State.	Number of mines.			Ore production from deep mines and average recovered value in gold and silver per short ton mined.					
	Placer.	Deep.	Total.	Total production.	Dry or siliceous ores.		Copper ores.		Zinc ores.[a]	
					Quantity.	Average value.	Quantity.	Average value.	Quantity.	Average value.
Alabama	1	2	3	5,079	5,079	$2.28	.....	.....	.....	.....
Georgia	26	11	37	1,750	1,750	3.00	.....	.....	.....	.....
Maryland and Pennsylvania[b]	.....	3	3	252,834	11	20.00	252,823	$0.53	.....	.....
New Hampshire	.....	1	1	300	.....	.....	.....	.....	300	.....
North Carolina	12	9	21	19,451	19,441	6.43	10	14.90	.....	.....
New Jersey	.....	1	1	529,443	.....	.....	.....	.....	529,443	.....
South Carolina	6	1	7	7,531	7,531	.92	.....	.....	.....	.....
Tennessee	.....	6	6	1,011,058	.....	.....	653,621	.09	357,437	.....
Virginia	.....	3	3	15,444	.....	.....	[c]1,440	.86	14,004	.....
Total	45	36	81	1,842,890	33,812	4.41	907,894	.07	901,184	.....

[a] No recovery of gold or silver from zinc ores.
[b] Includes lead-zinc ores.
[c] Only 55 tons yielded gold and silver; average is that for the 55 tons.

Number of copper, lead, and zinc producing mines, quantity of ore, and average pounds of metal recovered per short ton of ore in Eastern States in 1914, by States.

State.	Number of mines.		Copper ore.		Lead ore.		Zinc ore.	
	Copper.	Zinc.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.
Maryland and Pennsylvania	2	.....	*Short tons.* 252,823	2.6	*Short tons.*	.....	*Short tons.*	.....
New Hampshire	.....	1	.....	.....	.....	.....	300	41.5
New Jersey	.....	1	.....	.....	.....	.....	529,443	280.1
North Carolina	[a]1	.....	10	204.0	.....	.....	.....	.....
Tennessee	2	4	653,621	28.7	.....	.....	357,437	58.0
Virginia	[b]2	[c]1	1,440	41.0	.....	18.1	[d]14,004	24.8
Total	7	7	907,894	21.5	.....	18.1	901,184	188.3

[a] From residues.
[b] Part of copper from mine water.
[c] Includes lead and zinc mines.
[d] Includes lead-zinc ore.

REVIEW BY STATES.

ALABAMA.

The mine production of gold in Alabama in 1914 was $11,970, against $11,094 in 1913, and the by-product of silver was 199 fine ounces against 117 ounces in 1913. The total value of the production of precious metals was $12,080, against $11,165 in 1913. No copper, lead, or zinc production has been reported from Alabama in recent years.

The following table shows the mine production of gold, silver, and copper in Alabama since 1905, when the United States Geological Survey first collected detailed figures from the mines of the Eastern States:

Tonnage of ore treated and output of metals in Alabama, 1905–1914.

Year.	Ore sold of treated.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	
1905	16,425	$41,530	336	.....	$41,733
1906	8,565	24,921	124	.....	25,004
1907	18,400	25,982	439	84,678	43,208
1908	11,174	41,208	282	.....	41,357
1909	9,886	29,239	212	.....	29,349
1910	9,763	33,533	268	.....	33,678
1911	6,360	18,916	171	.....	19,007
1912	5,693	16,724	168	.....	16,827
1913	4,068	11,094	117	.....	11,165
1914	5,079	11,970	199	.....	12,080
Increase in 1914	1,011	876	82	.....	915

[a] Includes placer gold and silver.

The production for 1914 was mainly from 5,079 short tons of siliceous ore, with an average recoverable value in gold and silver of $2.28 a ton, against 4,068 tons and an average recovery of $2.74 in 1913, and 5,693 tons and an average recovery of $2.96 in 1912. The only placer gold reported was a small quantity obtained by the Clear Creek Gold Mining Co. from the Arbacoochee placers, in Cleburne County. These placers were worked experimentally by means of a small dredge from May until December, when the plant was dismantled.

In Clay County, near Pyriton, are several pyrite mines, all idle in 1913 and 1914, whose ores, formerly sold for their sulphur content, produced residues containing gold, silver, and copper. It is reported that the property of the Southern Mineral Development Co. at Pyriton, contains a large deposit of crystalline granular pyrite capable of producing first-class ore for acid manufacture, but that its development awaits a market for the ore. One assay in 1914 is reported to show a content of 5.20 per cent of copper and of $1.60 in gold per ton of the ore.

At the Storey mine, near Waldo, in Talladega County, now owned by the Gold Log Mining Co., a considerable quatity of ore was treated in a 10-ton 5-stamp mill, by amalgamation. The ore is siliceous and occurs in veins and lenses in the metamorphic schists. The mine and the mill were operated intermittently during the year, and considerable development was accomplished.

At the Hog Mountain mine, near Alexander City, in Tallapoosa County, an increased tonnage was treated in a 100-ton cyanidation and blanket-concentration plant, after crushing in rolls and tube mill. Concentrates made contained about 6.2 per cent of bismuth, but this was not paid for by the purchasers. The greater part of the ore treated was unoxidized, but a portion was from the oxidized zone, which extends from 40 to 60 feet from the surface. The veins are of quartz in intrusive granite, and a little pyrrhotite is reported present. The quantity of gold recovered by means of cyanidation was slightly in excess of that derived from concentrates, and most of the small yield of silver was derived from the concentrates shipped.

The old mine of the Dutch Bend Mining Co., also near Alexander City, which is equipped with a 20-stamp mill, was still idle because of litigation.

GEORGIA.

The production of gold in Georgia in 1914 was $16,270, against $15,108 in 1913, and that of silver was 67 fine ounces, against 75 ounces in 1913. This gives a total precious-metal output for Georgia in 1914 of $16,307, against $15,153 in 1913 and $14,407 in 1912. The gold production of Georgia during the last three years was less than half what it was in 1911 and about one-sixth of what it was in 1905. There has been no production of copper, lead, or zinc since 1907.

The following table shows the production for the years 1905 to 1914, inclusive:

Tonnage of ore treated and mine production of metals in Georgia, 1905–1914.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	16,000	$96,910	1,040	8,841	19,394	$103,400
1906	2,150	31,050	599	26,198	9,750	37,065
1907	4,727	64,808	864	22,800	14,400	70,701
1908	6,196	56,207	200	.....	.....	56,313
1909	8,549	60,620	202	.....	.....	60,725
1910	13,562	35,602	335	.....	.....	35,783
1911	3,737	35,070	212	.....	.....	35,182
1912	1,359	14,360	77	.....	.....	14,407
1913	2,614	15,108	75	.....	.....	15,153
1914	1,750	16,270	67	.....	.....	16,307
Increase (+) or decrease (−) in 1914	−864	+1,162	−8	.....	.....	+1,154

[a] Includes placer gold and silver.

There were 26 placers and 11 deep mines reported as producing gold and silver in Georgia in 1914, against 28 placers and 11 deep mines in 1913. From the placers were produced 534.20 fine ounces of gold and 29 fine ounces of silver, against 414.57 ounces of gold and 22 ounces of silver in 1913. The deep mines (all gold quartz) produced 252.86 ounces of gold and 38 ounces of silver in 1914, against 316.28 ounces of gold and 53 ounces of silver in 1913. The deep mines produced 1,750 short tons of siliceous gold ores in 1914, against 2,614 tons in 1913, which yielded an average precious metal recovery of $3 a ton in 1914, against $2.51 a ton in 1913.

The following table shows the production of gold and silver in Georgia, by counties, in 1914:

Mine production of gold and silver in Georgia, 1914, by counties, in fine ounces.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
Bartow and Cherokee	44.26	$915	4	$2	$917
Carroll and Douglas	34.88	721	2	1	722
Dawson and Milton	12.29	254			254
Forsyth and Hall	78.90	1,631	5	3	1,634
Haralson and Paulding	130.08	2,689	26	14	2,703
Lumpkin	201.77	4,171	11	6	4,177
McDuffie	48.23	997	7	4	1,001
Rabun and unknown	185.91	3,843	9	5	3,848
White	50.74	1,049	3	2	1,051
Total, 1914	787.06	16,270	67	37	16,307
Total, 1913	730.85	15,108	75	45	15,153

Bartow and Cherokee counties.—A nominal output of gold was reported in 1914 by M. I. Parham, of Allatoona, the result of operations at several prospects in Bartow and Cherokee counties. The Franklin property in Cherokee County was not worked, and the only gold recovered was that resulting from cleaning up dirt around the old mill.

Carroll County.—Near Villa Rica, in Carroll County, are a number of mines producing pyrite for the manufacture of sulphuric acid. The only reported production of gold was from the Chambers Vein mine, about 1½ miles from Villa Rica, which was operated whenever there was sufficient rainfall to supply water for surface mining.

Dawson and Milton counties.—The small production of gold from these counties was from several small placer mines. Most of the gold was recovered from the Taylor Creek mine, in Dawson County, where the gravels were hydraulically mined for about two months.

Douglas County.—The Pine Mountain saprolite deposit in Douglas County, which was operated by sluicing, was the only productive mine in 1914.

Forsyth and Hall counties.—A nominal output of gold was made from prospecting in Forsyth and Hall counties in 1914. A test run was made at the 5-stamp mill of the Faver mine in Forsyth County.

Haralson County.—At the Royal mine, near Tallapoosa, in Haralson County, the 100-ton cyanide plant was not operated in 1914. The mill is equipped with forty 750-pound stamps, a Blake crusher, a 25-ton Huntington mill, 5 Frue vanners, and 7 Wilfley tables. The plant was not active in 1914 other than experimentally. The Georgia Gold Mining Co. made a small output of placer gold from sluicing bench gravels on Tallapoosa River about 3 miles north of Tallapoosa. The work was mainly in testing the value of 472 acres owned by the company.

Lumpkin County.—The production of Lumpkin County was 201.77 fine ounces of gold, valued at $4,171, and 11 ounces of silver, valued at $6 in 1914, against a total value of gold and silver of $4,116 in 1913, and of $5,455 in 1912. Lumpkin County, especially at the Dahlonega and Auraria districts, has been a notable producer in the past, but the output has decreased greatly. In these districts there

are still a considerable number of small placers, and operations, including prospecting, continued on a small scale at some of the gold quartz mines. The Findley Ridge Mining & Power Co. has acquired several properties, including the Crown Mountain, Preacher, Griscomb, and Columbia mines.

McDuffie County.—The output of gold from McDuffie County was small. Most of the gold came from the Edwards mine, at which a 10-stamp mill was erected and some ore treated in 1914.

Paulding County.—The Peerless or Harper-Johnson property, in Paulding County, has a 110-foot 2-compartment vertical shaft, and considerable development work was accomplished and a good tonnage of ore was treated. The plant is equipped with a 10-stamp mill and 2 Snodgrass washers, and the crude ore, composed of quartz stringers in micaceous schists, is reported free-milling to the bottom of the oxidation zone, 85 feet from the surface. The 5-stamp mill of the Oklahoma Gold Mining Co., near Dallas, was in operation part of the year, and the output was good for the small quantity of ore milled.

Rabun County.—The bench gravels at the Carleton mine yielded considerable gold by ground sluicing. The average fineness of the gold recovered was about 0.930 fine, and the total gold yield of Rabun County was only exceeded in Georgia by that of Lumkin County.

White County.—The gold output of White County was 50.74 fine ounces, valued at $1,049, in 1914, and the total gold and associated silver production was $1,051, against $4,607 in 1913 and $1,773 in 1912. The operation of the Loud placers on Town and Tesnatee creeks, about 3 miles from Cleveland, was hampered by a shortage in the water supply, and the yield of gold was less than in 1913. The stamp mill at the White County mine was idle and the only output was from sluicing. The Calhoun placer on Dukes Creek and the Childs placer near Sautee were reported as producing in 1914. Only prospecting or development work was done at the Park, Stephens, and Franco American mines.

MAINE.

No production was reported from the Blue Hill or Cherryfield properties in Maine in 1914, and both were closed during the year.

MARYLAND.

In 1914 there was a small production of gold, silver, and copper from mines in Maryland. The only producing gold quartz property was the Great Falls mine, formerly called the Hill-Townsend, in Montgomery County. The old workings were cleaned out, the shaft was retimbered, and new drifts were run. The tube mill which has a capacity of 25 tons was only used to make tests of the ore mined, and small shipments of ore were also made to smelters. The results are stated to have been satisfactory. At the Maryland mines, near Cropley, in Montgomery County, now owned by the Buxton Gold Producing Co., a plant was being erected to treat ore and tailings on the old dump. There are two shafts on the property, one of which is 208 feet deep and the other 176 feet deep, and the drifts aggregate about 1,200 feet in length.

The United Milling & Smelting Copper Co., controlling the Eagle Metallic mine in Franklin and Adams counties, Pa., and the Dolly

Hyde and New London mines, near Frederick, Md., only operated the New London mine part of 1914. A small output of copper concentrates, carrying some gold and silver, was shipped in 1914.

MASSACHUSETTS.

All the mines and prospects in Essex County were reported idle in 1914, and the Essex was the only property on which development was contemplated in 1915.

NEW HAMPSHIRE.

The Warren zinc mine at Warren, in Grafton County, was not operated, but small shipments were made of roasted concentrates, averaging 45 per cent zinc content and resulting from work prior to the burning of the mill in 1905, to the experimental electric zinc smelting plant at Hartford, Conn. At the Madison mine, near West Ossipee, in Carroll County, the open pit was enlarged, some loose ore was removed, and a small plant to treat tailings was in course of erection.

NEW JERSEY.

There was no output from any of the various old copper mines of New Jersey in 1914.

The famous Mine Hill and Sterling Hill zinc mines, at Franklin Furnace and near Ogdensburg, N. J., respectively, were actively operated and produced an increased output of ore in 1914. The concentrating mills treated 343,285 short tons of ore, producing 277,930 short tons of concentrates. In addition, 186,158 short tons of ore were shipped. The total crude ore sold or milled in 1914 was, therefore, 529,443 short tons, against 490,434 tons in 1913. The total recoverable zinc output in 1914 (figured as spelter) was 148,506,500 pounds, against 144,312,560 pounds in 1913.

It must be distinctly understood that the value given for zinc in New Jersey is not that of the ore mined. It is the estimated smelter value of the recoverable zinc content of the ore after freight, haulage, smelting, and manufacturing are added. The value of the crude ore at the mine is less by at least the difference between the raw and the derived product.

The following table shows the zinc production of New Jersey for the years 1905 to 1914, inclusive:

Ore treated and mine production of zinc in New Jersey, 1905–1914.

Year.	Ore sold or treated.	Zinc.	Total value.[a]
	Short tons.	*Pounds.*	
1905	323,062	[b] 126,318,000	$7,452,762
1906	360,330	[b] 141,282,000	8,618,202
1907	329,205	[b] 119,176,000	7,031,384
1908	356,457	134,330,690	6,313,542
1909	475,838	165,020,071	8,911,084
1910	375,677	137,355,219	7,417,182
1911	374,064	154,890,900	8,828,781
1912	459,585	139,510,008	9,626,191
1913	490,434	144,312,560	8,081,503
1914	529,443	148,506,500	7,515,914
Increase (+) or decrease (−), 1914	+39,009	+4,193,940	−565,589

[a] The value given for zinc in New Jersey is not that of the ore mined. It is the estimated smelter value of the recoverable zinc content of the ore after freight, haulage, smelting, and manufacturing are added. The value of the crude ore at the mine is less by at least the difference between the raw and derived product.

[b] Estimate based on ore tonnage given by H. B. Kümmel, State geologist, and average per cent of zinc in ore.

NEW YORK.

There was no production of zinc or pyrite in 1914 at the Balmat and Edwards mines of the Northern Ore Co., in St. Lawrence County. The ore is reported to consist of zinc blende and pyrite in a limestone-serpentine gangue. Mine No. 1 has an inclined shaft 490 feet deep and about 3,000 feet of levels and drifts. Mine No. 2 has two inclined shafts, one 350 feet and the other 239 feet deep, and about 400 feet of drifts. A mill with a capacity of 50 to 100 tons, designed to recover part of the zinc concentrates on the jigs and partly by means of magnetic separation was erected. Before regular operations were started this mill was destroyed by fire in June, 1914. The erection of a new steel frame mill was undertaken, but it was not completed at the end of 1914.

NORTH CAROLINA.

The mine production of North Carolina in 1914 was 6,343.94 fine ounces of gold, valued at $131,141; 1,524 fine ounces of silver, valued at $843; and 20,434 pounds of copper, valued at $2,718. The output for 1913 was 6,116.92 fine ounces of gold, valued at $126,448; 1,812 fine ounces of silver, valued at $1,095; and 20,400 pounds of zinc, valued at $1,142. The total value of the output was, therefore, $134,702 in 1914, against $128,685 in 1913 and $205,214 in 1912.

North Carolina furnished again in 1914 much the greater part of the gold output of the Eastern States. Of the total production in the State, 12 placers (against 17 in 1913) produced 324.45 fine ounces of gold in 1914 (against 308.53 ounces in 1913). From 9 deep mines and prospects were produced 6,012.91 fine ounces of gold, 1,467 ounces of silver, and 20,434 pounds of copper, against 5,808.39 fine ounces of gold, 1,777 ounces of silver, and 20,400 pounds of zinc in 1913. There were 19,441 short tons of siliceous gold ores treated in North Carolina in 1914 having an average precious metal recovery of $6.43 a ton, against 11,186 tons having an average recovery of $10.83 in 1913.

The following table shows the production of gold, silver, copper, lead, and zinc in North Carolina for the years 1905 to 1914, inclusive:

Mine production of gold, silver, copper, lead, and zinc in North Carolina, 1905–1914.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	18,831	$125,685	20,230	480,000	.....	.....	$212,784
1906	20,368	82,131	30,769	703,775	.....	.....	238,575
1907	19,682	82,193	21,667	582,082	.....	.....	212,909
1908	9,088	97,495	1,260	19,393	.....	.....	100,723
1909	7,271	40,230	499	224,512	.....	.....	69,675
1910	14,914	68,045	9,053	140,514	.....	.....	90,778
1911	21,810	70,282	943	.....	.....	.....	70,782
1912	16,073	166,014	4,854	75,915	92,000	283,320	205,214
1913	12,274	126,448	1,812	.....	.....	20,400	128,685
1914	19,451	131,141	1,524	20,434	.....	.....	134,702
Increase (+) or decrease (−) in 1914	+7,177	+4,693	−288	+20,434	.....	.....	+6,017

[a] Includes placer production.

There has been no output of copper reported from the Cullowhee mine in Jackson County since 1912, and no shipments of ore containing lead or zinc from the Silver Hill or other mines in North Carolina were reported in 1914.

The following table shows the production of gold and silver, by counties, in North Carolina in 1914:

Mine production of gold and silver in North Carolina in 1914, by counties.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		
Anson and Randolph	3.14	$65	2	$1	$66
Burke and Caldwell	64.09	1,325	11	6	1,331
Cabarrus and Stanley	2.13	44			44
McDowell and Rutherford	246.28	5,091	22	12	5,103
Mecklenburg and Union	246.08	5,087	98	54	5,141
Montgomery	4,112.36	85,010	980	543	85,553
Rowan	1,669.86	34,519	411	227	34,746
Total	6,343.94	131,141	1,524	843	131,984

Anson and Randolph counties.—There was a very small production of gold from Anson County and from the Hoover Hill mine, near Caraway, in Randolph County, where a few tons of surface ore was treated and the mine was unwatered. At the Scarlett Copper mine, now controlled by the Tenvanoca Copper Co., the shafts were cleaned out and retimbered and a small quantity of ore hoisted.

Burke and Caldwell counties.—The gold output from these counties, amounting to $1,325, came from the Brindletown placers near Bridgewater in Burke County, and from the McKenzie mine at Hartland, in Caldwell County. There is a 5-stamp mill at the McKenzie mine, which was not in operation in 1914, and the gold was recovered by surface washing.

Cabarrus and Stanley counties.—The only production from these counties was a small amount of gold from small placer operations.

Catawba County.—None of the placer or deep mines in Catawba County reported any output in 1914.

Davidson County.—There were no operations reported at the Silver Hill and other old mines in Davidson County in 1914. The Conrad Hill mine, which has been idle since 1908, may be reopened and a mill erected.

Franklin County.—There was no output from the Portis mine near Essex in Franklin County, but preparations were being made to resume both hydraulic and deep mining.

Guilford County.—No production was reported from Guilford County, but preparations were made to work the old Gardner Hill mine and dump near Greensboro, and the erection of a 10-stamp mill was begun.

McDowell County.—A normal yield of placer gold was reported from near Dysartville, in McDowell County, in 1914.

Mecklenburg County.—There was a small production of surface gold in Mecklenburg County in 1914. The old Piedmont placer was sold to the Catawba Sand & Gravel Co. and was used as a sand and gravel plant. A small quantity of placer gold was recovered incidentally. The Thornton Lead & Steel Co. operated an experimental 5-ton smelter near Charlotte on North Carolina ores and residues for a short period, and some copper matte was shipped.

Montgomery County.—The gold production of Montgomery County in 1914 amounted to 4,112.36 fine ounces, against 5,716.77 ounces in 1913. The well-known Iola or Candor mine, the largest gold producer for several years east of the Black Hills, made a somewhat decreased production in 1914, but still much larger than any other mine in the South. The principal vein strikes N. 41° E. and dips N. 45° W. The ore bodies are reported to dip out of Iola ground and into the Uwarra (Montgomery) territory on the northeast and the Martha Washington ground on the southwest. The Golconda vein, striking parallel to the Iola and lying southeast of it, appears to cross the Iola ground, but has not been developed there. The Iola mine is opened by 5 shafts and extensive drifts to a depth of 650 feet, and is equipped with a 50-ton mill and modern cyanide plant. The stamps, weighing 1,750 pounds each, are the heaviest used in the United States. The equipment includes Dorr classifiers, tube mill, Parral agitators, and Kelly filters.

The Iola mine was sold in September, 1914, to the owners of the adjoining Martha Washington mine, into which, as stated, the Iola vein both strikes and dips. There was no production from the Martha Washington mine in 1914, but some development was done. It is the purpose of the owners to use the Iola mill to treat the ore from the Martha Washington mine.

The Uwarra (old Montgomery) mine adjoins the Iola on the northeast and the workings are in an extension of the Iola vein. There are two shafts, one 400 feet deep, to the northwest of the outcrop. The property is developed by 5,000 feet of drifts, and was equipped in 1913 with a 50-ton fine grinding and cyaniding plant at a cost of $50,000. Crushing and grinding will be in cyanide solution and mechanical agitation will be practiced. The mine and mill were operated continuously during 1914, and a good output was made.

The old Coggins mine is now owned by the Rich Cog Mining Co. The mine is opened by an inclined shaft which was deepened to 350 feet and other development work was also done in 1914. The only ore treated was that mined incidental to the development work. The mine is equipped with a 10-stamp amalgamation and concentrating plant erected in 1913 to replace the former plant destroyed by fire in 1912. The ore is crushed, stamped, amalgamated, and concentrated. The free gold is recovered, the gold-bearing sulphide concentrates are stored for shipment, and the tailings are impounded for future treatment.

The Hooper Gold Mining Co. was developing a prospect near Fisher; two shafts were sunk and a 5-stamp mill was built, which was not producing in 1914. The only placer gold recovery reported was by N. R. Stafford, from bench gravels near Troy.

Polk County.—No yield of gold was reported from Polk County, though the Double Branch mine, 9 miles northeast of Landrum, S. C., was prospected.

Rowan County.—The gold production of Rowan County was much larger in 1914 than in 1913. The large increase was partly caused by the reopening of the Gold Hill mine. The shaft at the mine is 755 feet in depth and the 40-stamp amalgamating and concentrating mill has a capacity of 60 tons. Some gold was recovered from placers in Rowan County, but the amount was small.

Rutherford County.—The Biggerstaff hydraulic mine near Golden, in Rutherford County, had the largest yield of placer gold in the State

Union County.—The Wentz property, near Matthews, made a nominal output from prospect work, but the greater part of the county production of gold came from the old Colossus or Howie mine, near Waxhaw, which is opened by a 355-foot vertical shaft and a 200-foot adit. The property is equipped with a 50-ton all-sliming cyanide plant, in which continuous agitation and decantation are practiced. The ore is sulphide with siliceous gangue and is oxidized to a depth of 40 feet. The mill was operated intermittently for about four months. Another 5 by 20 tube mill and 10 stamps are to be added to the equipment, which is expected to increase the capacity to 100 tons daily.

Yadkin County.—There was no gold produced from the Gross & Dixon mine near Cana in 1914, though some underground development was done and an air compressor and drills were added to the equipment, which includes a tube mill of 25 tons capacity.

PENNSYLVANIA.

There has been no production of gold, silver, lead, or zinc ores reported from Pennsylvania for many years, but since 1912 there has been annually a copper production yielding small quantities of precious metals in refining. The greater part of the output has been a by-product separated from magnetic ores of the Cornwall iron mine.

The following table shows the quantity of ore producing copper, silver, and gold, and the metal output from 1907 to 1914:

Ore treated and mine production of metals in Pennsylvania, 1905–1914.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Total value.
	Short tons.	*Value.*	*Fine ounces*	*Pounds.*	
1905	.....	.....	.....	.....	.....
1906	.....	.....	.....	.....	.....
1907	.....	.....	.....	.....	.....
1908	[a] 157,269	$704	.....	186,869	$25,371
1909	191,198	4,941	43	621,969	85,819
1910	218,183	5,640	50	927,360	123,442
1911	219,368	.....	.....	642,902	80,363
1912	214,000	.....	.....	473,060	78,055
1913	239,083	.....	.....	503,792	78,088
1914	252,768	.....	.....	646,016	85,920
Increase, 1914	13,685	.....	.....	142,224	7,832

[a] Estimated.

Adams and Franklin counties.—In Adams and Franklin counties, near the Maryland line, are a number of copper prospects in which native metal with epidote and calcite associated with diabase has been found. None of these were productive in 1914, and operations were suspended. The Eagle Metallic, one of these properties, is now controlled by the United Milling & Smelting Copper Co., of Frederick, Md., which also controls the New London and the Dolly Hyde mines referred to in the notes on Maryland.

Lebanon County.—At the Cornwall iron mines, in Lebanon County, an important output of pyritiferous magnetite was again treated in a 1,000-ton concentrator by the Gröndahl process, resulting in briquetted copper-bearing pyrite, which was shipped to copper smelters, and in clean, high-grade magnetite.

SOUTH CAROLINA.

The mine production of gold in South Carolina was 356.04 fine ounces, valued at $7,360, and that of silver was 33 ounces, valued at $18, a total value of the precious metal output of $7,378, and an increase of $2,473 over the total value of $4,905 in 1913. There has been no output of copper, lead, or zinc reported in South Carolina in recent years. The yield of 1914 was again mainly from deep mines, only 21.72 fine ounces of gold and no silver being reported from six small placers. At deep mines there were treated 7,531 short tons of siliceous ore and tailings, yielding an average recovery in precious metals of $0. 92 a ton, against an output of 1,010 short tons from seven mines in 1913, with an average recovery of $4.64.

The gold output of South Carolina the last two years has been much less than in former years, as shown in the following table giving the production for the years 1905 to 1914, inclusive:

Ore treated and mine production of metals in South Carolina, 1905–1914.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	
1905	49,493	$95,111	111	.....	$95,178
1906	49,327	78,959	92	.....	79,021
1907	36,195	54,765	124	.....	54,847
1908	16,795	53,715	226	1,600	54,046
1909	3,150	11,053	44	.....	11,076
1910	24,153	38,324	46	.....	38,349
1911	9,302	20,408	11	.....	20,414
1912	12,358	16,915	47	.....	16,944
1913	1,010	4,881	40	.....	4,905
1914	7,531	7,360	33	.....	7,378
Increase (+) or decrease (−), 1914	+ 6,521	+ 2,479	− 7	.....	+ 2,473

[a] Includes placer gold and silver.

Abbeville County.—At the Neel property, near Abbeville, in Abbeville County, the plant was closed down for lack of equipment to save the sulphides, which constitute more than two-thirds the value of the ores. The mine was prospected only in 1914.

The McCormick Mining Co. shipped some manganese ore from the Dorn mine in 1914, but the 10-stamp mill was not operated and no gold was recovered.

Cherokee County.—At the old Knott placer, near Gaffney, and from the land of the Gaffney City Land & Improvement Co., a nominal output of gold was made from surface working.

Lancaster County.—The Haile mine, near Kershaw, in Lancaster County, had a slightly increased output in 1914. A new cyanidation plant, equipped for continuous agitation and decantation and with a daily capacity of 40 to 50 tons, which was completed in 1913, was operated on old tailings, of which there is a large supply from operations of the old plant in former years. No ore was mined underground. The new plant is reported a success in the work for which it was designed.

Spartanburg County.—There were no mines operated in Spartanburg County, but a small quantity of gold was recovered by various prospectors from stream gravels.

York County.—Some prospect work was done on the old Dawson mine, near Smyrna, which formerly shipped considerable ore containing good values in gold. The Horn mine, also near Smyrna, did not ship any ore in 1914, but may resume operations in 1915.

TENNESSEE.

The production of precious metals in Tennessee in 1914 was 299.63 fine ounces of gold, valued at $6,194, and 97,402 fine ounces of silver, valued at $53,864, a decrease in value of $1,401 in gold and of $11,431 in the value of silver output. The production of copper was 18,737,656 pounds, valued at $2,492,108, and the output of zinc (figured as spelter) was 20,850,000 pounds, valued at $1,063,350. In 1913 the production of copper was 19,390,750 pounds, valued at $3,005,566, and that of zinc was 11,166,000 pounds, valued at $625,296. The copper output, therefore, decreased 653,094 pounds in 1914 and the zinc production increased 9,684,000 pounds, following an increase of 6,784,700 pounds in 1913, and was by far the largest output in the history of Tennessee. The net decrease in value of gold, silver, copper, and zinc was $88,236.

There have been no gold, silver, or lead mines producing in Tennessee in recent years, and the entire gold, silver, and copper output recorded was from 653,621 short tons of copper ore produced in the Ducktown district (against 652,253 tons in 1913), with an average precious metal recovery of $0.09 per ton, against $0.112 in 1913 and $0.105 in 1912, and with a copper recovery of 28.7 pounds per ton in 1914 against 29.73 pounds in 1913.

The zinc production was entirely from 357,437 short tons of zinc ore sold or treated, against 171,392 tons in 1913, which yielded an average of 58 pounds of zinc (figured as spelter), against 65.1 pounds in 1913, and no precious metals per short ton of crude ore treated.

There has been an extensive campaign of prospecting and development of zinc deposits in eastern Tennessee in recent years, and large bodies of ore have been located on the surface and underground, and several large zinc companies have been especially active in development and construction work. The outlook is for an important increase in the zinc production of Tennessee. Some lead prospecting has also been done in old and new fields, and there may be a revival of this industry in a small way, but the general outlook for important lead production in the Eastern States is not bright, from present knowledge.

The following table shows the output of Tennessee for the years 1905 to 1914, inclusive:

Ore treated and mine production of metals in Tennessee, 1905–1914.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	399,330	$4,362	95,522	14,541,425	.....	$2,330,606
1906	538,141	4,838	55,931	17,979,317	.....	3,512,320
1907	561,805	3,825	58,358	18,983,115	218,643	3,833,864
1908	638,033	3,699	57,696	19,459,501	688,149	2,635,275
1909	611,014	4,118	57,637	19,206,806	1,192,161	2,595,350
1910	578,434	3,113	81,239	16,837,727	1,932,555	2,289,731
1911	604,538	11,621	106,660	18,850,276	2,234,000	2,551,774
1912	635,576	8,265	89,893	18,483,173	4,381,300	3,415,583
1913	823,645	7,595	108,105	19,390,750	11,166,000	3,703,752
1914	1,011,058	6,194	97,402	18,737,656	20,850,000	3,615,516
Increase (+) or decrease (−) in 1914	+187,413	−1,401	−10,703	−653,094	+9,684,000	−88,236

[a] Includes placer gold and silver.

Jefferson County.—An important production of zinc was again reported from Jefferson County in 1914. The Loy mine, near Newmarket, developed by shallow shafts and open cuts, was in active operation and produced zinc carbonate ores, which were concentrated in a mill whose capacity is rated at 150 tons per 10-hour shift. The equipment includes washers, crushers, rolls, jigs, and tables. The oxidation zone extends to a depth of 75 to 80 feet. The zinc content of the milling ore is reported to average about 12 per cent and that of the concentrates about 40 per cent.

Russell & Pendergrass shipped a considerable quantity of zinc carbonate ore extracted from workings less than 50 feet in depth near Jefferson City. The average zinc content of the ore, which was sold to the Grasselli Chemical Co., was between 40 and 44 per cent.

Knox County.—The large increase in the output of zinc from Tennessee was mainly due to the operation at the Mascot mines of the American Zinc Co., of Tennessee. The quantity of sphalerite concentrates shipped in 1914 was nearly three times as large as the shipments in 1913, and the development work is said to have been most satisfactory. A description of the mine and mill of 1,200 tons daily capacity was given in this report for 1913.

Polk County.—The Polk County, London, and Burra Burra mines, of the Tennessee Copper Co., in the Ducktown district of Polk County, were actively operated again in 1914 and made an important output of sulphide copper ores. The deposits are massive and are worked by back stopes. The plant includes a 2,000-ton smelter with converters and equipment for recovery of sulphuric acid. The production of metals and acids was, as usual, large. The Mary and East Tennessee mines of the Ducktown Sulphur, Copper & Iron Co., producing ores similar to those of the Tennessee Co., were also actively worked and made a large output of ores, metals, and acid. The smelter has a capacity of 500 tons of ore a day, and recovery of sulphuric acid is also made.

Washington County.—Near Embreeville, in Washington County, an increased tonnage of zinc silicate ore was produced from open pits of the old Embree Iron Co. in 1914. The ore has been found to the depth of the hard dolomite, lying 20 to 100 feet from the surface, and occurs in residual clays beneath the overburden of soil and hematite and upon and between eroded pinnacles of the dolomite. The properties were worked for many years for the hematite iron ores, and a 200-ton iron blast furnace has been intermittently in operation until 1908, producing pig iron. The iron ores were mined by hydraulic methods, and the removal of the iron led to the eventual discovery of the zinc beneath, although it had been known for many years that the hematite carried some zinc. The ores are sorted by hand in the pits and then sent to the concentrating plant, where they are washed, picked, and dried for shipment. Crude ore averaging 35 per cent in zinc is shipped and that averaging 20 per cent is concentrated to a product averaging about 30 per cent. The crude ore is wet, and the product as shipped is reduced to a moisture content of from 5 to 10 per cent.

VERMONT.

The old copper mines in Orange County, among which are the Pike Hill, Seaboard, Union, Elizabeth, Orange, and Bicknell, were all reported idle in 1914 and no shipment of ore or slag was made.

VIRGINIA.

The production of gold in Virginia was 20.76 fine ounces, valued at $429, in 1914, against 29.22 ounces, valued at $604, in 1913, and 10.54 ounces, valued at $218, in 1912. The yield of silver was 1,458 ounces, valued at $806, in 1914, against 960 ounces in 1913 and 982 ounces in 1912. The production of copper increased from 56,287 pounds, valued at $8,724, in 1913, to 139,008 pounds, valued at $18,488, in 1914; but the output of lead decreased from 1,632,000 pounds, valued at $71,808, in 1913, to 254,000 pounds, valued at $9,906, in 1914. The production of zinc decreased from 5,438,000 pounds, valued at $304,528, in 1913, to 348,000 pounds, valued at $17,748, in 1914.

Virginia had the largest output of copper since 1909, but the output of zinc and lead, as shown above, was much smaller than usual.

The small gold production of Virginia in recent years has been from deep mines and was mainly from copper ores in 1914. The silver and copper were from pyritic copper ores and mine waters. The lead and zinc production was from 14,004 tons of zinc and lead-zinc ores in 1914, against an output of 30,034 short tons in 1913. Three deep mines and no placers were reported productive in Virginia in 1914.

The following table shows the production of gold, silver, copper, lead, and zinc in Virginia from 1905 to 1914, inclusive:

Ore treated and mine production of metals in Virginia, 1905–1914.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	800	$4,982	177	.....	.....	.....	$5,087
1906	1,000	14,832	250	.....	.....	.....	15,000
1907	26,822	8,288	221	58,880	118,400	.....	26,485
1908	12,877	2,451	236	24,775	76,190	1,410,961	75,361
1909	14,075	3,750	4,825	224,162	.....	116,627	41,698
1910	16,976	888	128	5,402	198,850	1,588,112	96,151
1911	17,782	3,064	21	90,000	830,542	2,064,818	169,394
1912	5,790	218	982	111,835	469,026	497,235	74,855
1913	30,916	604	960	56,287	1,632,000	5,438,000	386,244
1914	15,444	429	1,458	139,008	254,000	348,000	47,377
Increase (+) or decrease (−) in 1914	−15,472	−175	+498	+82,721	−1,378,000	−5,090,000	−338,867

[a] Includes placer gold and silver.

Fauquier County.—The Emigold and Cool Spring prospects, near Goldvein, were idle in 1914, and only prospecting was accomplished at the Franklin mine near Morrisville. There is a small plant on the Kelly mine near Summerduck, which is owned by C. M. Stevens. This plant was used in 1914 for testing ores from the Kelly and other mines. Some placer gold was produced in early years and later ore from shallow levels was treated by stamping and amalgamating.

Fluvanna County.—The Bowles mine reported no output in 1914, but a small mill may be erected in 1915.

Halifax County.—None of the mines in the Virgilina district in Virginia were active in 1914. Samples of copper ore from the Kay mine were shipped for test purposes,

Louisa County.—At the Allah Cooper property, near Mineral, in Louisa County, no work was reported in 1914. Cement copper was recovered and shipped, as usual, from mine waters of the Sulphur mine, which produces pyrite for the manufacture of sulphuric acid.

Prince William County.—The Cabin Branch pyrite mine, near Dumfries, again produced copper ore resulting in a recovery of copper, gold, and silver in 1914.

Spotsylvania County.—There was no production of ore nor output of metals in 1913 or 1914 from the mixed gold-silver-lead-zinc pyrite ores of the Grindstone or Holladay properties, which lie in a northeast extension of the pyritic mineral belt of Louisa County. Prospecting, however, was continued in 1914.

Wythe County.—The Austinville mine of the Bertha Mineral Co. produced both lead and zinc concentrates, the lead concentrates being shipped to smelters and the zinc to oxide furnaces. The ore is disseminated as sulphides of zinc, lead, and iron in a dolomite gangue and is oxidized to 235 feet in depth. The crude milling ore averages 5 per cent in zinc and 4 per cent in lead, and the lead and zinc concentrates each average 19 per cent. The mill has a capacity of 100 tons (10 hours) and contains crushers, jigs, and tables. The Bertha and the Little Wythe mines were idle, and the Ivanhoe Furnace Co. was sinking a shaft preparatory to the erection of a concentrating plant for the treatment of zinc blende ores.

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MANGANESE AND MANGANIFEROUS ORES.

By D. F. Hewett.

INTRODUCTION.

The production of manganese ores for 1914 was 2,635 tons, which represents a decline of 1,413 tons from that of 1913, although it compares favorably with the average production of the five preceding years, 2,394 tons. The production of all grades of manganiferous ores was 445,827 tons, of which 60,414 tons contained more than 15 per cent of manganese, and was used in the manufacture of low-grade ferromanganese and manganiferous pig iron. The production of this class of ore in 1913 was 672,146 tons, of which 35,850 contained more than 15 per cent manganese.

Imports of manganese ore declined 61,796 tons—from 345,090 tons in 1913 to 283,294 tons in 1914. Imports from Russia were only about two-fifths of those of the preceding year on account of the entrance of Turkey into the war in October and the closing of the Dardanelles to Russian traffic, and imports from India declined about 30 per cent. This decrease was partly offset by the increased importation from Brazil.

With the manganese alloys, the imports of ferromanganese decreased 35 per cent, although there was an increase in the imported tonnage of spiegeleisen. The prices of these materials have undergone great fluctuations during the year.

For several months prior to August 1 the price of standard 80 per cent ferromanganese was constant at about $40 a ton. During August prices ranged from $110 to $140 a ton, and although the material was quoted as low as $62 in November, the price advanced to $80 in December.

Although complete data are not available, it appears that the decrease in current supplies of manganese in the form of ores and the various alloys was only slightly less than the decrease in the production of steel. Had conditions in the steel industry been maintained as in the two preceding years, the lack of manganese would have been keenly felt. If, in the year 1915, an impetus is given to the steel industry on account of the temporary elimination of European sources of steel and steel products, the sources of manganese ore, other than Russia and India, may be taxed to the utmost and prices will probably show a further increase.

As indicated above, the outbreak of the European war has greatly disturbed the manganese ore industry and that of the manufacture of ferromanganese. These, as well as a number of other mineral industries, have been suddenly compelled to establish new sources of materials that are in many cases uniquely adapted to special uses.

In order to understand the character of this adjustment it is desirable to review briefly the manganese-ore industry since the beginning of the modern steel industry from 1865 to 1870, when the development of the Bessemer and open-hearth processes created a demand for carbon-bearing manganese alloys. Although complete statistics are not available for the period from 1870 to 1880, it appears that the ores needed for this use were derived about equally from domestic and foreign deposits and that there was a period from 1884 to 1890 when the domestic production possibly exceeded the imports. During this period the mines of Virginia furnished more than one-half the domestic supply. Since 1888, however, there has been a tendency toward the steady decline of the domestic production, except during several short periods when activity among the mines of Georgia and Arkansas served to augment the product of the Virginia mines. At the same time the imports have consistently increased, and these rather than the domestic output have responded to the changing conditions in the steel industry. (See Table 1.)

From 1890 to 1898, many countries contributed to the imports, notably Russia, Turkey, Chile, and Cuba. The deposits of the Caucasus region, though known in 1848,[1] did not begin to export ore until 1879. The statistics showing the extent to which these ores were imported by the United States prior to 1893 are not available. Manganese ore was first exported from India in 1892,[2] and the exports have risen from 674 tons in that year to the enormous figure of 637,444 tons in 1912. According to Branner,[3] manganese ore was first exported from Brazil in 1894, and although from 1895 to 1902 the United States received about half of the quantity exported, during the last few years a much smaller portion has been received, and the imports from India have been greater than those from any other country.

The decline in the output of domestic mines has without doubt been due both to the exhaustion of known deposits as well as to their inability to compete with foreign sources at prevalent prices. The most important reason why the ores from India, Russia, and Brazil have so largely displaced domestic ores, in spite of the great distances that they are transported, lies in the character of the deposits.

With very few exceptions, such as the ore lenses of the Cuyuna Range, Crow Wing County, Minn., which locally yield ore of good grade without treatment, most of the known manganese ore deposits of the United States yield material that must be washed or concentrated in order to produce a marketable product. In the more important deposits, such as those of the Appalachian Valley, Piedmont region, and Arkansas, the ratio of concentration commonly varies from 3 to 1 to 20 to 1, although with a few deposits, such as that exploited by the Myers mine in Campbell County, Va., this ratio has been for considerable periods as low as 3 to 2. It has recently been stated that it is improbable that any mine in Virginia can mine at a profit by underground methods material yielding by concentra-

[1] Drake, Frank, The manganese industry of the Caucasus: Am. Inst. Min. Eng. Trans., vol. 28, p. 191, 1898.

[2] Fermor, L. L., The manganese deposits of India: Geol. Survey India Mem., vol. 37, pt. 3, p. 421, 1909.

[3] Branner, J. C., The manganese deposits of Bahia and Minas, Brazil: Am. Inst. Min. Eng. Trans., vol. 29, p. 756, 1899.

tion less than one-fifth its weight of washed ore.[1] This feature of the deposits necessitates the mining of large quantities, involves the expense of washing, and leads to the early exhaustion of the deposit. On the other hand, the deposits of India, Russia, and Brazil yield, by sorting only, material rich enough to be smelted or even adapted to special uses. A small part of the shipping ore from the Russian deposits during the last few years has been concentrated and cleaned by washing. The hope, therefore, of developing under normal conditions large supplies of manganese ores in the United States that can compete with the foreign product appears to lie in the discovery of deposits containing ore not requiring washing or concentration. A relatively small amount of development has thus far been done on the lenses of the Cuyuna Range, and although most of the ores contain less than 15 per cent of manganese, further exploitation may prove the existence of masses of richer ore.

Domestic production and imports into the United States of manganese alloys and ore from important foreign sources, in long tons, 1890–1914.

Year.	Steel.	Ferromanganese.		Spiegeleisen.		Manganese ore.				
	Production.	Production.	Imports.	Production.	Imports.	Production.	Total imports.	Imports from—		
								Russia.	India.	Brazil.
1890	4,277,071	.....	.....	.....	.....	10,287	34,154	.....	.....	.....
1891	3,904,240	.....	.....	.....	.....	22,452	23,825	.....	.....	.....
1892	4,927,551	.....	.....	.....	.....	13,013	53,572	.....	.....	.....
1893	4,019,095	.....	.....	.....	.....	7,718	68,113	[a] 33,070	([b])	.....
1894	4,412,032	.....	.....	.....	.....	6,368	44,655	[a] 23,360	.....	([c])
1895	6,114,834	.....	.....	.....	.....	9,547	86,111	[a] 55,987	.....	.....
1896	5,281,659	.....	.....	.....	.....	10,083	31,489	[a] 3,600	.....	.....
1897	7,156,957	.....	.....	.....	.....	11,103	119,901	38,910	14,400	12,083
1898	8,932,857	.....	.....	.....	.....	15,957	114,805	46,396	5,944	17,031
1899	10,639,857	.....	.....	.....	.....	9,935	133,349	73,397	17,950	23,115
1900	10,188,329	([d])	([e])	([d])	([e])	11,771	256,252	132,121	10,650	54,451
1901	13,473,595	59,699	20,750	231,822	25,827	11,995	165,722	32,600	11,000	48,029
1902	14,947,250	44,525	50,368	153,403	68,813	7,477	235,576	3,338	64,170	102,550
1903	14,534,978	35,901	41,519	156,700	122,015	2,825	143,056	5,576	35,900	76,910
1904	13,859,887	57,076	21,813	132,370	4,623	3,146	108,519	11,959	10,200	66,875
1905	20,023,947	62,186	52,841	227,797	55,457	4,113	257,033	24,650	101,000	114,670
1906	23,398,136	55,520	84,359	244,980	103,268	6,921	221,260	13,805	154,100	30,260
1907	23,362,594	55,918	87,400	233,430	48,994	5,604	209,021	1,000	95,300	52,922
1908	14,023,247	40,642	44,624	111,376	4,579	6,144	178,203	250	143,813	17,150
1909	23,955,021	82,209	88,934	142,831	16,921	1,544	212,765	14,486	115,140	35,600
1910	26,094,919	71,376	114,228	153,055	25,383	[f] 2,258	242,348	33,120	140,965	53,750
1911	23,676,106	[f] 74,602	80,263	[f] 104,013	20,970	[f] 2,457	176,852	19,103	103,580	41,600
1912	31,251,303	[f] 125,378	99,137	[f] 102,561	1,015	[f] 1,664	300,661	83,334	123,645	81,580
1913	31,300,874	[f] 119,495	128,070	[f] 106,980	77	[f] 4,048	345,090	124,337	141,587	70,200
1914	23,513,030	[f] 100,731	82,997	[f] 76,625	2,870	[f] 2,635	283,294	52,681	103,583	113,924

[a] Drake, Frank, The manganese ore industry of the Caucasus: Am. Inst. Min. Eng. Trans., vol. 28, p. 191, 1898.
[b] First shipments made from India.
[c] First shipments made from Brazil.
[d] Figures for ferromanganese and spiegeleisen combined prior to 1901.
[e] Figures for fiscal years only available prior to 1901.
[f] Marketed production.

[1] Rowan, M. A., Mining and production of manganese in Virginia: Min. and Eng. World, vol. 41, p. 714, 1914.

SOURCES OF MANGANESE.

Manganese minerals.—For commercial purposes materials containing manganese are separated into four classes: (1) Manganese ores, (2) manganiferous iron ores, (3) manganiferous silver ores, and (4) manganiferous zinc residuum. This classification is based on the character of the materials now available in the United States and is due largely to the nature of the deposits, and as it is purely commercial it may be incomplete if applied to resources in foreign countries, or it may contain superfluous classes. Thus the United States alone possess large deposits of franklinite, which when roasted yields manganiferous zinc residuum. Though manganese forms a part of about a hundred minerals and is a relatively widespread element, practically all the manganese of commerce is derived from material containing one or more of the first seven of the minerals named in the following table:

Principal manganese minerals.

Mineral.	Composition.	Percentage of manganese.
Polianite	MnO_2	63.2
Pyrolusite	$MnO_2.n\,H_2O$	60–63
Psilomelane	$MnO_2.(MnKBa)O.n\,H_2O$	45–60
Wad	Hydrous impure mixture of manganese oxides	5–50
Manganite	$Mn_2O_3.H_2O$	62.4
Braunite	$3Mn_2O_3.MnO.SiO_2$	69
Franklinite	$(FeZnMn)O.(FeMn)_2O_3$	10–19
Rhodochrosite	$MnO.CO_2$	47.56
Rhodonite (manganese pyroxene)	$MnO.SiO_2$	41.9
Tephroite (manganese olivine)	$2MnO.SiO_2$	54.3
Spessartite (manganese garnet)	$3MnO.Al_2O_3.3SiO_2$	33.3

Manganese ores.—Commercial manganese ores are those which contain at least 35 per cent manganese and otherwise conform to the specifications of the trade in which they are used. Deposits of manganese ore[1] occur in many parts of the United States, but are most abundant in the Appalachian and Piedmont regions, in the southern Mississippi Valley, and on the Pacific coast. Small deposits occur in the New England, Rocky Mountain, and Great Basin regions. The principal producing districts up to the present time have been the James River-Staunton River and the Blue Ridge regions in Virginia, the Cave Springs and the Cartersville districts in Georgia, the Batesville district in Arkansas, and the Livermore-Tesla districts in California. Districts of minor importance are the New River region in Virginia, the northeastern Tennessee region, the McCormick region in South Carolina, and the Little Grande district in Utah. Mining and shipping in Virginia is now confined to the Blue Ridge and the James River-Staunton River regions.

[1] For details concerning manganese minerals the reader is referred to a recent exceptionally complete and valuable work by L. Leigh Fermor (The manganese deposits of India: Geol. Survey India Mem., vol. 37, pt. 1, pp. 1–209, 1909).

Bulletin 427 of the United States Geological Survey (Manganese deposits of the United States, by E. C. Harder, 1910) contains brief descriptions of most of the known deposits of the United States, as well as the important deposits of the world, and concise summaries of the chemistry and mineralogy of manganese.

Manganiferous iron ores.—Manganiferous iron ores consist of mixtures of manganese and iron oxides and hydrous oxides, which though usually containing manganese in excess of 5 per cent, may contain as little as 1 per cent. The proportion of iron in such ores is highly variable, but usually exceeds 40 per cent. Manganiferous iron ores occur in the United States chiefly in the New England, the Appalachian, and the Lake Superior regions, and minor deposits are found in the southern Mississippi Valley and in the Rocky Mountain region. High-grade manganiferous iron ore used for its manganese content occurs in the Appalachian region. Other manganiferous iron ores, which are so low in manganese that they are classed as iron ores, are produced in the Appalachian and the Lake Superior districts. In the blast furnace they yield a "high-manganese" pig iron, which is used for special purposes.

Manganiferous silver ores.—Manganiferous silver ores consist of mixtures of manganese and iron oxides and hydrous oxides, with small quantities of silver and lead minerals. As a rule the iron content exceeds the manganese content, but locally the iron is altogether absent.

Manganiferous silver ores are divided, according to their uses, into three classes:

1. The greater part of the manganiferous silver ores mined are used for their content of silver and lead. Their content of manganese and iron insures many of these ores a higher price because of their fluxing value.

2. Some manganiferous silver ore is too low in silver and lead to be used as a source of these metals but is sufficiently high in manganese and iron to be used for the manufacture of ferromanganese and spiegeleisen, a use that is made also of the high-grade manganiferous iron ores already mentioned.

3. A third class of manganiferous silver ore is too low in silver and lead to be used primarily for their content of these metals and too low in iron and manganese to be used for the manufacture of iron-manganese alloys. This ore is sold to the smelters as flux, the iron and manganese becoming waste products, and the silver and lead content being recovered during the smelting.

Manganiferous silver ores occur in the Rocky Mountain and Great Basin regions, the principal producing locality being Leadville, Colo. Leadville ores have been used in making spiegeleisen from time to time, but none are now used for this purpose.

Manganiferous zinc residuum.—Manganiferous zinc residuum is an artificial furnace product consisting of manganese and iron oxides in a matrix of slag. Manganiferous zinc residuum is obtained from zinc volatilizing and oxidizing furnaces using New Jersey zinc ores. The residuum consists largely of iron and manganese oxides, the zinc having been removed by volatilization and collected as zinc oxide. The crude ores contain franklinite, zincite, and willemite and are obtained only from the Franklin Furnace district, New Jersey. Large quantities of zinc residuum are used annually in the manufacture of spiegeleisen.

MANGANESE ORE.

PRODUCTION IN THE UNITED STATES.

The following table shows the quantity, value, and average price per ton of the manganese ore produced and marketed in the several States for 1912, 1913, and 1914:

Marketed production of manganese ore in the United States, 1912–1914, by States, in long tons.

State.	1912			1913			1914		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
California	(a)	(a)					(b)	(b)	
South Carolina	(a)	(a)					b 911	b $8,812	$9.67
Virginia	a 1,664	a $15,723	$9.45	c 4,048	c $40,480	$10.00	1,724	18,565	10.77
Total	1,664	15,723	9.45	4,048	40,480	10.00	2,635	27,377	10.39

a Virginia includes California and South Carolina.
b South Carolina includes California.
c Includes small quantity produced in 1911 and 1912, but not reported for those years.

Reports have been received from 74 manganese mine owners in 16 States. A production is reported from 8 mines in Virginia, 5 in California, 1 each in Arkansas, Colorado, New Mexico, South Carolina, and West Virginia, but in several cases no ore was shipped.

The following table shows the total production of manganese ore in the United States, by States. The figures showing the production prior to 1880 are only approximate; those for the years since 1910 represent the marketed production, based upon reports from the individual producers. Virginia, Georgia, and Arkansas have produced 94 per cent of the total, but for 12 years the production of the latter two States has been negligible.

Production of manganese ore in the United States, 1838–1914, in long tons.

Year.	Alabama.	Arkansas.	California.	Georgia.	Indian Territory, Michigan, Missouri, Montana, and Nevada.	North Carolina.	Pennsylvania, South Carolina, and South Dakota.	Tennessee.	Utah and Vermont.	Virginia.	West Virginia and other States.	Total.
1838–1879	.....	410	.....	.....	.....	.....	.....	.....	.....	.....	.....	410
1866–1879	.....	.....	.....	19,950	.....	.....	.....	.....	.....	.....	.....	19,950
1867–1879	.....	.....	5,500	.....	.....	.....	.....	.....	.....	18,000	.....	23,500
1880	.....	.....	.....	1,800	.....	.....	.....	.....	.....	3,661	300	5,761
1881	.....	100	.....	1,200	.....	.....	.....	.....	.....	3,295	300	4,895
1882	.....	175	.....	1,000	.....	.....	.....	.....	.....	2,982	375	4,532
1883	.....	400	.....	[a] 400	.....	[a]	.....	.....	.....	5,355	.....	6,155
1884	.....	800	.....	[a] 400	.....	[a]	.....	.....	.....	8,980	.....	10,180
1885	.....	1,483	200	2,580	(Nev.) 200	.....	.....	.....	.....	18,745	50	23,258
1886	75	3,316	100	6,041	(Nev.) 30	14	.....	50	.....	20,567	.....	30,193
1887	.....	5,651	.....	9,024	.....	14	.....	.....	.....	19,835	.....	34,524
1888	.....	4,312	1,500	5,568	(Mich.) [b] 100	[b]	(Pa.) [b] 22	[b]	[b]	17,646	[b] 50	29,198
1889	.....	2,528	53	5,208	(Nev.) 15	47	(S. C.) 124	30	(Vt.) 1,576	14,616	.....	24,197
1890	.....	5,339	386	749	(Nev.) 100	14	.....	.....	.....	12,699	.....	19,287
1891	.....	1,650	705	3,575	(Ind. T.) 206	.....	(S. Dak.) 19	.....	(Vt.) 49	16,248	.....	22,452
1892	.....	6,708	.....	826	.....	.....	.....	.....	.....	6,079	.....	13,613
1893	.....	2,020	400	724	.....	.....	.....	482	.....	4,092	.....	7,718
1894	.....	1,934	278	1,277	.....	.....	.....	922	.....	1,797	(W. Va.) 100	6,308
1895	.....	2,991	525	3,856	.....	.....	(Pa.) 460	.....	.....	1,715	.....	9,547
1896	.....	3,421	284	4,085	.....	2	(Pa.) 265	.....	.....	2,018	(W. Va.) 13	10,088
1897	.....	3,240	484	3,332	(Mich.) 37	.....	(Pa.) 354	11	.....	3,650	.....	11,108
1898	22	2,662	541	6,689	.....	.....	.....	381	.....	5,662	.....	15,957
1899	.....	356	115	3,089	(Mo.) 16	90	(Pa.) 12	19	.....	6,228	(W. Va.) 10	9,935
1900	.....	145	131	3,447	(Mont.) 137	.....	.....	30	.....	7,881	.....	11,771
1901	17	91	610	4,074	(Mo.) 28	.....	.....	400	(Utah) 2,500	4,275	.....	11,995
1902	.....	82	846	3,500	.....	.....	(S. C.) 8	.....	.....	3,041	.....	7,477
1903	.....	.....	16	500	.....	.....	(S. C.) 25	.....	(Utah) 483	1,801	.....	2,825
1904	.....	.....	60	.....	.....	.....	.....	.....	(Utah) 32	3,054	.....	3,146
1905	.....	.....	1	150	.....	.....	.....	20	.....	3,947	.....	4,118
1906	.....	62	1	.....	.....	.....	.....	30	(Utah) 800	6,028	.....	6,921
1907	.....	.....	100	.....	.....	.....	(S. C.) 800	100	.....	4,604	.....	5,604
1908	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,144	.....	6,144
1909	.....	.....	[c]	.....	.....	.....	.....	[c]	.....	[c] 1,544	.....	1,544
1910 [d]	.....	[e]	.....	.....	.....	.....	.....	.....	.....	[e] 2,258	.....	2,258
1911 [d]	.....	.....	[f]	.....	.....	.....	.....	.....	.....	[f] 2,457	.....	2,457
1912 [d]	.....	.....	[g]	.....	.....	.....	(S. C.) [g]	.....	.....	[g] 1,664	.....	1,664
1913 [d]	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,048	.....	4,048
1914 [d]	.....	.....	501	.....	.....	.....	(S. C.) 410	.....	.....	1,724	.....	2,635
Total	114	49,876	13,337	93,044	869	181	2,499	2,475	5,440	248,340	1,198	417,373

[a] Georgia includes North Carolina. [b] "Other States" includes Nevada, North Carolina, South Carolina, Tennessee, and Vermont. [c] Virginia includes California and Tennessee. [d] Marketed production. [e] Virginia includes Arkansas. [f] Virginia includes California. [g] Virginia includes California and South Carolina.

STOCKS.

The following table shows the quantities of mined manganese ore on hand at the mines at the close of 1912, 1913, and 1914:

Stock of manganese ore on hand at the mines Dec. 31, 1912, 1913, and 1914, by States, in long tons.

State.	1912	1913	1914
Arkansas	.....	25	35
California	105	105	475
Colorado	.....	.....	15
New Mexico	.....	.....	40
Virginia	410	1,855	510
West Virginia	.....	.....	40
Total	515	1,985	1,115

The following tables, compiled by the Bureau of Foreign and Domestic Commerce, Department of Commerce, show the imports of manganese ore into the United States from different countries and by ports of entry for 1912, 1913, and 1914:

Imports of manganese ores into the United States, calendar years 1912–1914, by countries, in long tons.

Country.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Brazil	81,580	$510,300	70,200	$445,680	113,924	$736,769
Russia	83,334	490,306	124,337	712,324	52,681	490,331
British India	128,645	644,162	141,587	710,024	103,583	504,981
France	2,021	25,071	1,114	12,578	5	1,580
Netherlands	.....	.....	.....	.....	2,505	52,213
Japan	.....	.....	3	78	40	1,320
Germany	3,245	70,644	2,014	103,612	1,713	92,273
United Kingdom	752	14,099	227	12,082	8,321	136,206
Canada	55	2,021	5	631	64	1,357
Belgium	2	26	.....	.....	450	5,913
All other countries	1,027	12,555	5,603	32,671	8	1,177
Total	300,661	1,769,184	345,090	2,029,680	283,294	2,024,120

Manganese ores imported into the United States, calendar years 1912–1914, by customs districts, in long tons.

Customs district.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Philadelphia, Pa.	143,537	$788,243	167,418	$916,395	107,701	$635,977
Baltimore, Md.	153,039	900,273	170,056	961,622	147,260	1,045,307
New York, N. Y.	3,345	65,036	1,222	88,949	5,257	162,766
Boston, Mass.	8	235	77	3,129	259	3,527
New Orleans, La.	110	670	370	2,375	163	1,044
All other	622	14,727	5,947	57,210	22,654	175,499
Total	300,661	1,769,184	345,090	2,029,680	283,294	2,024,120

The figures for the years 1868 to 1888 represent imports from Canada only; those from 1889 to the present time represent total imports.

Imports of manganese ore into the United States, 1868–1914, in long tons.[a]

Year ending—	Quantity.	Year ending—	Quantity.	Year ending—	Quantity.
June 30—		Dec. 31—Contd.		Dec. 31—Contd.	
1868	1,017	1883	1,326	1900	256,252
1869	488	1884	603	1901	165,722
1870	1,402	1885	1,684	1902	235,576
1871	1,056	1886	1,818	1903	146,056
1872	1,206	1887	1,630	1904	108,519
1873	838	1888	1,182	1905	257,033
Dec. 31—		1889	4,286	1906	221,260
1873	1,031	1890	34,154	1907	209,021
1874	782	1891	28,825	1908	178,203
1875	203	1892	58,572	1909	212,765
1876	412	1893	68,113	1910	242,348
1877	891	1894	44,655	1911	176,852
1878	626	1895	86,111	1912	300,661
1879	1,886	1896	31,489	1913	345,090
1880	2,179	1897	119,961	1914	283,294
1881	1,704	1898	114,885		
1882	894	1899	188,349	Total	[b] 4,142,910

[a] Figures prior to 1889 represent imports from Canada only, total importations from other countries for these years not being obtainable.
[b] This total duplicates the importation from Jan. 1 to June 30, 1873.

PRODUCTION IN PRINCIPAL PRODUCING COUNTRIES.

The following table gives the latest available statistics with regard to American and foreign production of manganese ore.

Wherever possible the figures are taken from the official publication of the country concerned, which is the case with Canada, Belgium, France, German Empire, Italy, and Spain; otherwise, Mines and Quarries, London, has been used except for 1913, when figures for all countries except Italy and the United Kingdom are from Mineral Industry, New York.

Production of manganese ore in principal producing countries, 1909–1914, in long tons.

Country.	1909	1910	1911	1912	1913	1914
North America:						
Canada	.....	.....	5	67	.....	25
Nova Scotia	(a)	22	134	208	(b)	(b)
United States	1,544	2,258	2,457	1,664	4,048	2,635
South America:						
Brazil	236,982	249,954	171,172	152,431	180,738	(b)
Europe:						
Austria	17,761	15,447	15,703	12,275	16,280	(b)
Belgium	6,171	.....	.....	.....	.....	(b)
Bosnia and Herzegovina	5,602	3,937	3,543	4,577	4,626	(b)
France	9,252	7,874	5,906	5,488	7,610	(b)
German Empire	75,962	79,291	85,921	(d)	(b)	(b)
Greece	5,289	40	721	7,595	547	(b)
Hungary	11,733	13,061	14,523	10,662	18,706	(b)
Italy	4,626	4,134	3,460	2,599	1,596	(b)
Russia	726,978	719,907	[e] 572,028	[e] 911,742	1,289,370	(b)
Spain	7,703	8,471	5,519	17,126	21,254	(b)
Sweden	5,189	5,719	5,347	5,082	3,938	(b)
Turkey	[f] 7,459	[g] 12,008	(b)	(b)	(b)	(b)
United Kingdom	2,768	5,467	4,987	4,170	5,393	3,439
Asia:						
China	1,500	(b)	(b)	(b)	(b)	(b)
India	642,675	800,907	670,290	637,444	718,520	(b)
Japan	8,708	11,121	9,615	11,862	(b)	(b)
Philippine Islands	(h)	.....	.....	.....	.....	(b)
Portuguese India	(i)	(i)	(i)	(i)	(b)	(b)
Africa:						
Cape Colony	.....	(j)	[c] 116	.....	(b)	(b)
Natal	.....	51	.....	.....	(b)	(b)
Oceania:						
Australia	603	815	1,151	328	27	6
New Zealand	6	5	.....	.....	.....	(b)

[a] Not stated.
[b] Statistics not yet available.
[c] Exports.
[d] Statistics not available for Empire. Prussia produced 91,018 long tons.
[e] Exported from Batum and Poti.
[f] Year ending March, 1909.
[g] Exported from Stratoni.
[h] Quantity not stated. Value of production, $6,250.
[i] Quantity not stated. Exports valued at $13,607 in 1909, $18,609 in 1910, $13,366 in 1911, and $779 in 1912.
[j] Quantity not stated. Exports valued at $7,786.

MANGANIFEROUS ORES.

Manganiferous ores are of two classes: (1) Those which contain iron greatly in excess of manganese and which are smelted direct to a manganiferous cast iron containing 1 to 4 per cent manganese, or those in which manganese equals or is in excess of the iron and which, with other iron ores, is smelted to a similar product or low-grade ferromanganese; and (2) those which are used for fluxing, the manganese oxides forming a more fluid slag. Of the first class are ores of the Lake Superior region, Arkansas, and Virginia. So far as can be ascertained, the manganiferous ores of Colorado are the only ores used for fluxing, and the smaller demand for these ores is due to the fact that the smelting of iron ores is of minor importance compared to the smelting of lead and copper ores containing gold and silver, in which industry refractory mixtures frequently require the use of manganiferous iron ores to aid in fluxing. A part of the Colorado ores was used in the manufacture of spiegeleisen in 1914.

During the last few years explorations on the Cuyuna range, in Minnesota, have shown the presence of large bodies of manganiferous iron ore containing from 2 to 20 per cent manganese. During 1914 the American Manganese Manufacturing Co., owning furnaces at Dunbar, Pa., smelted a large quantity of this material to low-grade ferromanganese and spiegeleisen.

For use as a flux the value of manganiferous iron ore, like that of many ores which contain both precious and base metals, depends on several factors, among the more important of which are: (1) Combined manganese and iron content, (2) content of silica, (3) content of precious metals, (4) the deductions and adjustments of these factors, based on the temporary demands of the smelter that buys such ores. The ores produced in the Leadville district, Colorado, for 1914, range in composition as follows: Manganese, 5 to 37 per cent; iron, 16 to 45 per cent; siliceous material (insoluble), 7 to 34 per cent; silver, 2 to 25 ounces per ton; gold, trace; lead, trace to 2.5 per cent. The average composition of the entire product is: Manganese, 17 per cent; iron, about 33 per cent; siliceous material, about 11 per cent; silver, 4.8 ounces; gold, trace; lead, 1.3 per cent.

For such ores smelters pay at the rate of 15 cents per unit (or per cent) for the excess over 40 per cent of the combined iron and manganese content after deducting the silica or siliceous material, and for silver 95 per cent of the content at New York quotations. The deduction of 40 per cent from the combined iron-manganese content is made in lieu of a charge for smelting. By this method of calculating, the value of the Leadville ores, exclusive of that of the precious metals, ranges from nothing to $1.50 a ton, and the average value of the total production in 1914 was 34 cents a ton. If the value of the silver content be added to this, the total is $2.86 a ton.

Prior to 1912 it was possible to state only the total value of these ores, as but a single figure—the gross value—has been reported by producers. More complete data are now available and the present method of calculation is more closely in accord with that adopted by the Survey.

The following table shows the production of Arkansas and Colorado for 1911, 1912, 1913, and 1914, and the average price per ton:

Marketed production of manganiferous ores used principally for fluxing or other purposes in Colorado and Arkansas, 1911–1914, in long tons.

Year.	State.	Percentage of manganese.	Quantity.	Value.	Average price per ton.
1911	Arkansas	20	2,177	$4,354	$2.00
	Colorado	4–40	41,753	109,340	2.62
1912	Arkansas	20	1,332	2,997	2.25
	Colorado	6–24	48,618	12,646	*a* .23
1913	Arkansas	16–25	9,650	19,250	1.99
	Colorado	2–37	49,753	5,874	*a* .12
1914	Arkansas	(*b*)	1,970	3,940	2.00
	Colorado	5–37	39,881	13,688	*a* .34
Total			195,134	172,089	.88

a For Colorado ores since 1912, price covers excess manganese and iron only and excludes value of precious metals.
b Not stated.

The production of manganiferous ores in the United States from 1885 to 1914 is shown in the following table:

Production of manganiferous ores in the United States, 1885–1914, in long tons.

Year.	Arkansas.	Colorado.*a*	Colorado.*b*	Lake Superior region.	Virginia.	Other States.	Total.
1885						(Mont.) 4,263	4,263
1886			*c* 60,000	257,000			317,000
1887			*c* 60,000	210,000	1,025	*d* 726	271,751
1888			*c* 60,000	201,036		*e* 1,096	262,132
1889			64,987	81,359			146,346
1890		6,397	51,840	61,863			120,100
1891		964	79,511	132,511			212,986
1892		2,942	62,309	147,431	3,000		215,682
1893	160	5,766	55,962	110,648	1,188	(N. C.) 20	173,744
1894		7,022	31,687	198,466			237,175
1895		13,464	54,163	112,265			179,892
1896		9,072	138,079	329,640			476,791
1897		16,519	149,502	184,585		(Vt.) 1,200	351,806
1898		18,848	99,651	268,862		(Pa.) 100	387,461
1899		29,355	79,855	732,490			841,700
1900		43,303	188,509	334,274			566,086
1901		62,385	228,187	512,084		(N. C.) 20	802,676
1902		13,275	194,132	884,939	3,000		1,095,346
1903		14,856	179,205	566,835	2,802		763,698
1904	600	17,074	105,278	365,572			488,524
1905	3,321	45,837	81,738	720,098			850,994
1906	8,900	32,400	(*f*)	*g* 1,000,000			1,041,300
1907	4,133	67,514	32,197	314,316		(N. M.) 7,000	425,160
1908	4,066	15,973	35,581	467,140	274		523,034
1909	3,325	12,905	52,119	775,035	305		843,689
1910	5,030		55,770	558,634	301		619,735
1911	2,177		41,753	477,920	507		522,357
1912	1,332		48,618	816,984	1,567		868,501
1913	9,650		49,753	612,743			672,146
1914	1,970	2,100	37,781	402,754	1,222		445,827
Total	44,664	437,971	2,378,167	11,837,484	15,191	14,425	14,727,902

a Manganiferous silver ore used in the manufacture of spiegeleisen and ferromanganese.
b Manganiferous silver ore used for flux; mainly from Colorado, but in a few cases probably including other Western States.
c Contains some Montana ore.
d Georgia 195 tons, Maine 50 tons, and Vermont 481 tons.
e North Carolina, South Carolina, and Tennessee 96 tons, and Vermont 1,000 tons.
f Not recorded.
g Estimated.

MANGANIFEROUS ZINC RESIDUUM.

Unique deposits of zinc ore containing franklinite, willemite, zincite, calcite, and minor silicate and other minerals occur near Franklin Furnace, N. J. By mechanical and electromagnetic processes of separation three products are obtained from these ores, one containing the greater proportion of the franklinite and the remaining two the other zinc minerals. The franklinite product is first roasted with anthracite to eliminate the zinc, which is recovered as zinc oxide, and the residue, containing 12 per cent manganese and 40 per cent iron, is smelted to spiegeleisen.

The production of manganiferous residuum has been approximately constant since 1911. The price given for this material, as stated elsewhere, is arbitrary, as it is not sold in the open market, but reduced to spiegeleisen by the company that produces it. The production, value, and price per ton from 1905 to 1914 are given in the following table:

Production of manganiferous zinc residuum in the United States, 1905–1914, in long tons.

Year.	Quantity.	Value.	Average price per ton.
1905	90,289	$90,289	$1.00
1906	93,461	93,461	1.00
1907	93,413	280,239	3.00
1908	110,225	330,675	3.00
1909	141,264	423,792	3.00
1910	137,173	411,519	3.00
1911	109,296	291,344	2.67
1912	104,670	314,010	3.00
1913	102,239	306,717	3.00
1914	100,198	300,594	3.00
Total	1,082,228	2,842,640	2.63

The following table shows the production of manganiferous zinc residuum from 1889 to 1914:

Production of manganiferous residuum from zinc roasting in the United States, 1889–1914, in long tons.[1]

1889	43,648	1899	65,010	1909	141,264
1890	48,560	1900	87,110	1910	137,173
1891	38,228	1901	52,311	1911	109,296
1892	31,859	1902	65,246	1912	104,670
1893	37,512	1903	73,264	1913	102,239
1894	26,981	1904	68,189	1914	100,198
1895	43,249	1905	90,289		
1896	44,953	1906	93,461	Total	1,890,774
1897	33,924	1907	93,413		
1898	48,502	1908	110,225		

VALUE OF MANGANESE ORES.

The value of ores containing manganese depends on their mineralogical nature as well as their purity. The prices paid for ores of medium grade, for which the demand is greatest, are relatively stable,

[1] The manufacture of spiegeleisen from manganiferous residuum was begun in 1870, but there is no record of the tonnage of raw material used prior to 1889.

but the value of high-grade ores, which are consumed in much smaller quantities, fluctuates greatly.

The value of the ores used in the metallurgical industries varies with their content of metallic manganese and is governed largely by the specifications announced from time to time by the Carnegie Steel Co., Pittsburgh, Pa. The specifications now in use are given below: [1]

Schedule of prices paid per ton of 2,240 pounds for domestic manganese ore delivered at Pittsburgh or Bessemer, Pa., and South Chicago, Ill.

Prices are based on ores containing not more than 8 per cent silica or 0.20 per cent phosphorus and are subject to deductions as follows: For each 1 per cent in excess of 8 per cent silica there shall be deduction of 15 cents per ton; fractions in proportion.

For each 0.02 per cent, or fraction thereof, in excess of 0.20 per cent phosphorus there shall be a deduction of 2 cents per unit of manganese per ton.

Ores containing less than 40 per cent manganese or more than 12 per cent silica or 0.225 per cent phosphorus are subject to acceptance or refusal at the buyer's option.

Settlements are based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken being deducted from the weight.

Percentage of metallic manganese in ore.	Price per unit of manganese in cents.
Over 49	23
46 to 49	25
43 to 46	24
40 to 43	23

According to these specifications, the prices paid for ores range from $8 to $13.50 a ton.

The value of an ore adapted to use as an oxidizer varies with its content of manganese dioxide, and, in contradistinction to those used in metallurgical industries, does not depend, except incidentally, on its content of manganese metal. It is usually specified that ore required for use as an oxidizer shall contain at least 80 per cent manganese dioxide and not more than 1 per cent iron. As far as can be ascertained, there appears to be no established schedule, such as exists in the steel industry, but brokers supply ore under guaranteed specifications in lots ranging from 5 to 100 tons. Ores for these purposes have until recently been derived largely from the Caucasus region, Russia, but as no ores are now shipped from Russia a shortage has resulted and it is reported that prices as high as $70 a ton have been paid. Few of the known deposits of the United States are capable of producing more than a small quantity of ore containing less than 1 per cent iron.

As the manganese content of manganiferous iron ores and manganiferous silver ores is used only indirectly, the value of these ores depends on local conditions in the metallurgical industries which consume them.

The prices paid for manganiferous iron ores containing 15 to 35 per cent manganese range from $3.50 to $6 a ton.

Manganiferous silver ores are of value principally for their content of iron, silver, or metals other than manganese, which only rarely adds more than $3 a ton to their value. The more impure ores, such as will serve for coloring glass and pottery, are sold at prices ranging from $2 to $6 a ton f. o. b. works. Producers supply the

[1] Circular issued by Carnegie Steel Co., Aug. 5, 1914.

greater part of these ores directly to the trades, and prices are wholly subject to contract.

Manganiferous zinc residuum is not sold in the open market, but is smelted to spiegeleisen by the companies that produce it.

FERROMANGANESE AND SPIEGELEISEN.

PRODUCTION.

The marketed production of ferromanganese in 1914 was 100,731 tons, a decrease of 18,764 tons, or about 15 per cent, from the output of 1913. This coincides with a decrease in imports of 45,073 tons, or 35 per cent. In the case of spiegeleisen the marketed production was 76,625 tons in 1914, or 30,355 tons lower than in 1913. The imports of spiegeleisen were much larger in 1914 than in 1913. As shown in a preceding table, the combined production and imports of these alloys show fluctuations that closely coincide with the production of steel.

As heretofore, practically all the domestic production of ferromanganese was derived from imported ores. A small tonnage of medium-grade ferromanganese was made from manganiferous iron ores of the Cuyuna Range. For the first time since 1909, spiegeleisen was produced from the manganiferous ores of Leadville.

Production of spiegeleisen and ferromanganese in the United States, 1872–1914, in long tons.

1872	4,072	1887	42,498	1902	212,934
1873	3,930	1888	48,901	1903	192,661
1874	4,070	1889	76,628	1904	219,446
1875	6,903	1890	133,180	1905	289,983
1876	5,907	1891	127,766	1906	300,500
1877	7,807	1892	179,131	1907	339,348
1878	9,530	1893	81,118	1908	152,018
1879	12,438	1894	120,180	1909	225,040
1880	17,503	1895	171,724	1910	226,216
1881	18,827	1896	131,940	1911 [1]	173,615
1882	19,610	1897	173,695	1912 [1]	227,939
1883	21,941	1898	213,769	1913 [1]	226,475
1884	30,262	1899	219,763	1914 [1]	177,356
1885	30,956	1900	255,977		
1886	42,841	1901	291,461	Total	5,473,044

The content of manganese in spiegeleisen and ferromanganese varies slightly according to the source of the ores, and the method of manufacture and the prices of the alloys depend on the percentage of manganese.

The following table shows the range in prices for the iron-manganese alloys for 1914:

Prices per long ton for iron-manganese alloys during 1914.

Alloy.	1914				
	Percentage of manganese and silicon.	January.	Maximum.	Minimum.	December.
Ferromanganese [a]	75–80 Mn	49.46	120.00	38.16	80.16
Spiegeleisen [a]	15–20 Mn	26.00	27.00	22.50	25.00

[a] Compiled from weekly reports published in Steel and Iron, of Pittsburgh.

[1] Marketed production. Figures collected by United States Geological Survey.

The following table, compiled from data furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce, shows the quantity and value of the imports for consumption of ferromanganese and spiegeleisen from 1903 to 1914:

Ferromanganese and spiegeleisen imported and entered for consumption, 1903–1914, in long tons.

Year.	Ferromanganese.		Spiegeleisen.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	41,519	$1,699,666	122,015	$2,709,317	163,534	$4,408,983
1904	21,813	707,037	4,623	132,461	26,436	839,498
1905	52,841	1,884,651	55,457	1,336,104	108,298	3,220,755
1906	84,359	4,953,644	103,268	2,942,940	187,627	7,896,584
1907	87,400	5,354,656	48,994	1,399,381	136,394	6,754,037
1908	44,624	1,860,604	4,579	125,054	49,203	1,985,718
1909	88,934	3,396,381	16,921	356,447	105,855	3,752,828
1910	114,228	4,341,071	25,383	489,049	139,611	4,830,120
1911	80,263	3,015,062	20,970	405,444	101,233	3,420,506
1912	99,137	3,906,920	1,015	28,094	100,152	3,935,014
1913	128,070	5,682,915	77	2,173	128,147	5,685,088
1914	82,997	3,619,607	2,870	71,147	85,867	3,690,754
Total	926,185	40,422,274	406,172	9,997,611	1,332,357	50,419,885

NOTES ON DOMESTIC MANGANESE DEPOSITS.

California.[1]—During the year 1914 several manganese deposits were discovered, some old mines were reopened, and companies were formed to exploit them. The most promising deposits are those opened by the Thomas mine, near Ukiah, Mendocino County, and by the Shasta Copper Co. near Heroult, Shasta County. Both these deposits were prospected during the year and a small shipment was made from the first mine to the Noble Electric Steel Co., Heroult.

The Ladd mine, in San Joaquin County, was reopened and ore was shipped from accumulated stock.[2] The Western Manganese Co. has erected a refining plant at Alameda and operates the Ladd mine under lease. Manganese ore of good grade has been mined at Kleinfelter, San Bernardino County, but none has been shipped.[3]

The Noble Electric Steel Co. made experiments with the manufacture of ferromanganese in the electric furnace.

Colorado.—For some years there has been considerable speculation concerning the source of the manganese and manganiferous iron ores which are important in the oxidized zone of the Leadville district. These ores range from a trace to 40 per cent manganese; 8 to 50 per cent iron; trace to 5 per cent lead; 5 to 34 per cent siliceous material (insoluble), with small amounts of gold and silver, and although from time to time they have been used in the manufacture of ferromanganese and spiegeleisen, recently they have been smelted for the precious metals they contain. These ores form large masses adjacent to the ore bodies containing the sulphides of lead, zinc, and iron, which are characteristic of the district. It has recently been recognized[4] that siderite containing appreciable manganese occurs in

[1] Dolbear, S. H., The manganese industry in California: Min. Press [Min. and Sci. Press], vol. 110, p. 172, 1915.
[2] Dolbear, S. H., The Ladd manganese mine: Min. Press [Min. and Sci. Pres], vol. 110, p. 258, 1915.
[3] Dolbear, S. H., op. cit., p. 175.
[4] Argall, Phillip, Siderite and sulphides in Leadville ore deposits: Min. and Sci. Press, vol. 109, pp. 50–54, 128–134, 1914.

considerable quantity as irregular masses in a number of mines and has probably been formed by the replacement of the adjacent limestone. It is suggested that the manganese and manganiferous ores have been formed by the weathering of this siderite.

A deposit of manganese ore of good grade is reported [1] in the western part of San Miguel County, 40 miles west of the nearest railway station.

Minnesota.—Although the presence of manganese in some of the ore lenses of the Cuyuna range has been known for some years through records of drill holes,[2] only recently has there been the attempt to determine the distribution and relations of the manganiferous ore. The largest masses of manganiferous ore have been found in the south half of T. 24 N., R. 26 W., and the north half of T. 46 N., R. 26 E., Crow Wing County. Although much of the ore contains less than 5 per cent manganese, it is reported that large quantities ranging from 6 to 20 per cent manganese have been developed. Two companies report a production for 1914.

New Mexico.—A deposit of manganese ore of good grade, reported to have been discovered in 1900, has recently been reopened about 2 miles northwest of Rincon, N. Mex.[3]

Oklahoma.—Manganese ore was discovered during the year near Bromide, Okla., in sec. 9, T. 2 S., R. 8 E., on the property of the Bromide Oolitic Stone Co.

South Carolina.—The Eureka Manganese Co. carried on explorations at the McCormick mine near McCormick, and shipped a small quantity of ore. These deposits have been described recently by Hafer.[4]

Utah.—Discovery of low grade manganese ore near Castleton, Utah, is reported.[5]

Virginia.—Of the 28 properties in Virginia, from which reports have been received, 17 were idle during 1914, 8 reported a production, and prospecting was carried on at 3. The most important events of the year in the industry of the State were the formation of several new companies, the Crimora Manganese Corporation, which now operates the Crimora mine; the Oxford Mining & Manganese Corporation, which reopened the Myers mine of the Piedmont Manganese Co.; and E. M. Harris & Co., which purchased control of the Umbarger mine, in Smyth County. There was greater activity in the industry than in 1913, but no important discoveries are reported.

Washington.—Exploration was continued on the deposits near Omak, Okanagan County, and activity on deposits near Lake Cushman, Mason County, is reported.

West Virginia.—Manganese ore was discovered in 1914 near Sweet Springs, Monroe County. A small tonnage of ore was mined during exploration, but none was shipped.

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[1] Communication from J. M. Belisle, Norwood, Colo.
[2] Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull., 427, p. 131, 1910.
[3] Communication from C. E. Morgan, Rincon, N. Mex.
[4] Hafer, Claud, Manganese in South Carolina: Eng. and Min. Jour., vol. 98, p. 1135, 1914.
[5] Communication by Charles A. Finley, Castleton, Utah.

NOTES ON FOREIGN MANGANESE DEPOSITS.

Brazil.—According to Consul Robert Frazer, of Bahia,[1] no manganese ore has been shipped from Bahia since 1912.

The only mines in this State are named Pedras Prestas, Sape, and Oaha, all owned by the same company and situated about 20 miles from the town of Nazareth, on an estuary of the Bay of Bahia. The Sape and Oaha mines are connected with the Nazareth Railway by a narrow-gage line 5¼ miles long, over which the ore is hauled to the Nazareth Railway siding and dumped into cars, which carry it 14 miles to the town itself, beside the bay. There it is put into sailing lighters and taken to the ship. From the Pedras Prestas mine the ore is also taken to the Nazareth Railway by a narrow-gage line, down which the cars run by gravity, the empty trucks being hauled back to the mine by mules.

It is stated that the ore contains 43 to 49 per cent metallic manganese, and would average 45 per cent, and that an average analysis would be: Metallic manganese, 45 per cent; phosphorus, 0.016 per cent; silica, 3 to 4 per cent; iron, 3 to 6 per cent; moisture, 2 to 3 per cent.

The cost of mining, railway transportation, lighterage, export duties, etc., is given as $2.80 a ton.

Cuba.—The Cauto Mining Co., at San Nicolas, north of Santiago, Province of Oriente, is mining about 1,500 tons of ore monthly, which contains 43 to 47 per cent manganese, 9 per cent silica, 2 per cent iron, and 0.05 per cent phosphorus Small lots are selected which contain 85 to 87 per cent manganese dioxide. The ore is mined from an open cut, hand-picked, and raised by an incline to a log washer where it is prepared for shipment. There is prospecting in the vicinity of Santiago, but no other mines are shipping at present.[2]

Russia.—E. Schnass[3] describes the resources of the Caucasus region. The geologic features of the region are presented and the lead and zinc deposits described. The manganese deposits are briefly mentioned.

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[1] Daily Consular and Trade Reports, p. 476, 3d quarter, 1914.
[2] Personal communication from William Pitt, Santiago, Cuba.
[3] Schnass, E., Eine Studienreise durch den Kaukasus: Gluckauf, vol. 1, pp. 918–923, 959–967, 1914.

BAUXITE AND ALUMINUM.[1]

By W. C. Phalen.

BAUXITE.

PRODUCTION.

The production of bauxite in the United States in 1914 was 219,318 long tons, valued at $1,069,194, an increase of 9,077 tons, or 4.3 per cent, in quantity and of $71,496, or 7.1 per cent, in value, as compared with the production in 1913.

The States which produced bauxite were, as usual, Alabama, Arkansas, Georgia, and Tennessee. Arkansas was the largest producer owing to the extensive operations of the American Bauxite Co. in Saline County. The Globe Bauxite Co. operated at Chemical Spur, Saline County, and the Republic Mining & Manufacturing Co. near Little Rock, Pulaski County. The National Bauxite Co. also leased bauxite lands near Little Rock and began operations at the beginning of the year. The output in Arkansas in 1914 exceeded that of 1913. Georgia ranked second among the States in the production of bauxite in 1914, but its output was far below that of Arkansas and much less than in 1913. The production of bauxite in Alabama and Tennessee also decreased compared with that of 1913.

The average price of bauxite per long ton at the mines was, in 1911, $4.82; in 1912, $4.81; in 1913, $4.75; and in 1914, $4.87.

Production of bauxite in the United States, 1889–1914, by States, in long tons.

Year.	Georgia.	Alabama.	Arkansas.	Tennessee.	Total.	
					Quantity.	Value.
1889	728				728	$2,366
1890	1,844				1,844	6,012
1891	3,301	292			3,593	11,675
1892	5,110	5,408			10,518	34,183
1893	2,415	6,764			9,179	29,507
1894	2,050	9,016			11,066	35,818
1895	3,756	13,313			17,069	44,000
1896	7,313	11,051			18,364	47,338
1897	7,507	13,083			20,590	57,652
1898					25,149	75,437
1899	15,736	14,499	5,045		35,280	125,598
1900	19,739		3,445		23,184	89,676
1901	18,038		867		18,905	79,914
1902	22,677		4,645		27,322	120,366
1903	22,374		25,713		48,087	171,306
1904	21,913		25,748		47,661	235,704
1905	15,173		32,956		48,129	240,292
1906	25,065		50,267		75,332	368,311
1907	34,271		63,505		97,776	480,330
1908	14,464		37,703		52,167	263,968
1909	22,227		106,874		129,101	679,447
1910	33,096		115,836		148,932	716,258
1911	30,170		125,448		155,618	750,649
1912	19,587	14,173	126,105		159,865	768,932
1913	27,409		182,832		210,241	997,698
1914	18,547		200,771		219,318	1,069,194

[1] The statistical tables of bauxite, aluminum, and aluminum salts in this report were prepared by Miss M. B. Clark, statistical clerk.

CONSUMPTION.

The following table gives the annual production, imports, consumption, and value of bauxite in the United States during the last five years:

Production, imports, and consumption of bauxite in United States, 1910–1914, in long tons.

Year.	Production.		Imports.		Consumption.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1910	148,932	$716,258	15,669	$65,743	164,601	$782,001
1911	155,618	750,649	43,222	164,301	198,840	914,950
1912	159,865	768,932	26,214	95,431	186,079	864,363
1913	210,241	997,698	21,456	85,746	231,697	1,083,444
1914	219,318	1,069,194	24,844	96,500	244,162	1,165,694

WORLD'S PRODUCTION.

The following table shows the world's production of bauxite from 1911 to 1913, as far as the figures are at present available:

World's production of bauxite, 1911–1913, in long tons.

Country.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	155,618	$750,649	159,865	$768,932	210,241	$997,698
France	250,818	508,788	254,851	507,649	(a)	(a)
United Kingdom	6,007	6,297	5,790	6,881	6,055	7,606
Italy	5,600	12,300	6,596	20,618	6,843	16,101
India	12	24	950	2,511	(a)	(a)
Total	418,055	1,278,058	428,052	1,306,591	.....	.....

a Statistics not available.

BAUXITE INDUSTRY, BY STATES.

ALABAMA.

The Republic Mining & Manufacturing Co. was the only one that operated in Alabama in 1914. The company worked near Rock Run, Cherokee County, in the eastern part of the State.

ARKANSAS.

The State of Arkansas has produced for several years more than 80 per cent of the bauxite mined in this country. The reason for this is that the American Bauxite Co., the principal producer in the United States, has concentrated its work in this State. The greater part of the production comes from what is known as the Bauxite district, also known as the Bryant district, which lies about 22 miles southwest of the city of Little Rock and covers an area of about 12 square miles in Bryant Township, Saline County. Bauxite, the town from which the material is shipped, is located on the Chicago, Rock Island & Pacific Railway 5 miles east of Benton, the county seat of

Saline County. The mines are located on the Bauxite & Northern Railway, a spur built from Bauxite Junction, on the St. Louis, Iron Mountain & Southern Railway system. This spur crosses the Rock Island tracks at Bauxite station.

The second and less important district is known as the Fourche Mountain district, which is located immediately south of the city limits of Little Rock, in Pulaski County, and which embraces an area somewhat larger than the Bauxite district. The two areas are about 15 miles apart.

During 1914 three other companies besides the American Bauxite Co. operated in Arkansas. The National Bauxite Co. began work at the beginning of the year on a property located 7 miles south of Little Rock on the Rock Island Railway. This particular property had never been worked before. The Globe Bauxite Co. worked at Chemical Spur, Saline County, and the Republic Mining & Manufacturing Co. operated near Little Rock, in Pulaski County.

GEORGIA.

The Republic Mining & Manufacturing Co. reported a small production from the district near Rome, Floyd County, in 1914. For many years this company has mined bauxite north of Rome in the vicinity of Hermitage. The main operations of the company in this State in 1914 were at McIntyre, Wilkinson County, and east of Andersonville, Sumter County, in the central Georgia district. The National Bauxite Co. also worked in the McIntyre district. The Cherokee Mining Co. mined ore near Hall's station, Linwood post office, Bartow County.

TENNESSEE.

CHATTANOOGA DISTRICT.

Bauxite was mined in 1914 at only one locality in the vicinity of Chattanooga, namely, near Sherman Heights, on the southeastern slope of Missionary Ridge. The work was done by the National Bauxite Co. Work at the Tunnel deposits which were described in this report for 1913 was not continued in 1914.

Sherman Heights.—The Sherman Heights deposits are most conveniently reached by trolley to Sherman Heights, and are about half a mile south of the tunnel of the Southern Railway, which pierces the ridge in this suburb. These deposits must not be confused with the so-called Tunnel deposits referred to above, which are located considerably farther south at the east end of the Hamilton County tunnel.

There were formerly two mines or pits at Sherman Heights situated within 250 yards of each other on a northeast-southwest line. Only the northeast pit, known as the Perry mine, was operated in 1914. The Perry mine has been constantly enlarged, until it is now nearly 150 feet deep. Their surface diameter is approximately 250 to 300 feet. Test pits have been sunk 30 to 35 feet below the bottom. The ore continued at this depth, and the limits of its downward extension have not been reached. It appears to pitch to the northwest into Missionary Ridge and undercutting must be soon resorted to. The bauxite removed from this opening runs up into the thousands of tons.

The ore from this mine was formerly hoisted on an inclined plane but is now removed by more modern methods, as the depth of the pit has made the old method expensive and dangerous. The ore is shoveled into a peculiar form of bucket or skip having a capacity of 1 cubic yard and provided with grappling-iron attachment. The skip is hoisted vertically and moved along on a wire cable to the drier, located on the hill south of the pit. The cable is stretched between two towers, 600 or 700 feet apart. This mine is worked in winter as well as in summer, but the weather is of course an important factor in regulating the time and extent of operations. The water which collects in the bottom of the pit, owing to the impervious character of the material, is removed by a Fairbanks-Morse pump. The clay and siliceous ore obtained during the progress of mining may be removed to one side and later hauled out of the pit. Part of the clay impurities are disposed of in this manner. When this mine was visited by the writer in October, 1914, the company was at work removing clay to prevent its washing in on the ore during the winter months. Two steam shovels and one Ledgerwood hoisting engine were employed in this work.

There are on the ground two rotary driers with a capacity of three carloads a day. The ore in the process of drying goes through both. They are about 40 feet in length, are 2½ and 3 feet, respectively, in diameter, and make 7 or 8 revolutions a minute. They are constructed of steel plate and have a spiral metal blade on the inside by which the ore is worked along. The fuel used is either wood or coke. After the ore is dropped near the drier from the skip it is fed into a bucket elevator which lifts it to the upper end of the 36-inch drier. It then travels forward toward the fire in the first of the twin driers. From the lower end of this drier the ore falls into another bucket elevator, from which it is fed into the upper or higher end of the second drier. The fires are at the lower end of the first drier and at the upper end of the second drier, an arrangement adopted solely for convenience in firing, and therefore the ore travels against the flame and gases in the first drier and with them in the second.

Though the ore is not washed, there is a log washer on the ground. The log washers used at bauxite mines are rather crude affairs but serve very well for the purposes for which they are designed. They consist generally of two logs to which are attached flat metal plates arranged in spiral form. As the ore moves forward and upward in the washers a stream of water flows in the opposite direction, thus removing the lighter clayey impurities. A screen at the end of the washer where the feeding takes place serves to remove the lump or hard ore, which is not washed. The capacity of the washer is two cars, or nearly 60 tons, a day.

The bauxite shipped from the Chattanooga district, as well as from the southern Appalachian region in general, is used in the chemical industries. For such use the maximum content in iron oxide (Fe_2O_3) allowed is 2 per cent. To obtain run of ore which will not average more than 2 per cent iron oxide it has to be mixed, that is, ore containing a larger proportion of iron oxide than 2 per cent is mixed with higher-grade material containing little or no iron oxide until the iron content falls below the maximum allowed. The ore is shipped for use in the manufacture of alum and other

aluminum salts. That the ore shipped from this region is of a very high grade is indicated by the following analyses of representative carload lots:

Analyses of bauxite from Missionary Ridge, Tenn.

	1	2	3	4	5	6
Insoluble	12.13	11.15	11.33	11.07	13.12	12.65
Loss on ignition	28.97	30.04	30.20	30.00	30.39	30.31
Alumina (Al_2O_3)	57.56	57.63	57.37	57.83	55.11	55.50
Iron oxide (Fe_2O_3)	1.34	1.18	1.10	1.10	1.38	1.34

KEENBURG, CARTER COUNTY.

Bauxite was mined at the Gibson mine near Keenburg, Carter County, northeastern Tennessee, for the first time in 1912, by the National Bauxite Co. This company worked the property until February, 1914, when it sold its interests to the Watauga Mining Co., which produced ore during the remainder of the year. The occurrence of bauxite near Keenburg had been known for some years prior to the beginning of mining operations. The mine is located about 1 mile northeast of the Keenburg station of the Virginia & Southwestern Railway, which is about 4 miles due north of Elizabethton, the county seat. Keenburg is most conveniently reached by the way of either Johnson City or Bristol, both on the main line of the Southern Railway between Bristol, Va., and Knoxville, Tenn. From Johnson City a narrow-gage line (the East Tennessee & Western North Carolina Railroad) runs to Cranberry, N. C., by way of Elizabethton. From Bristol the Virginia & Southwestern Railway runs through Keenburg, approximately 1 mile from the Gibson mine.

USES OF BAUXITE.

The chief uses of bauxite were outlined in this report for 1913, as follows: (1) As raw material in the production of metallic aluminum; (2) in the manufacture of aluminum salts; (3) in the manufacture of bauxite bricks; (4) in the manufacture of alundum (fused alumina) for use as an abrasive. The use of bauxite in the manufacture of calcium aluminate to give a quick set to plaster compositions should be added, as well as the extended use which alundum is finding in the refractory industries.

1. The use of bauxite in the production of metallic aluminum is by far the most important of those enumerated. A large part of the output of Arkansas is used for metallic aluminum, and the figures of production from this State have shown phenomenal growth during recent years. A large part of the imported French bauxite is also used in the manufacture of metallic aluminum.

2. Only the purer bauxite is used in the manufacture of chemicals, such as alum, aluminum sulphate, and aluminum salts in general. Freedom from oxide of iron is essential in the material to be used in the chemical manufactures.

3. Bauxite is used in the manufacture of bauxite bricks for furnace linings. The purer the bauxite used, the more refractory is the resulting product; and, moreover, the addition of bauxite to refractory clays not only increases their content of alumina but also their refrac-

toriness. The method of making bauxite brick, a representative analysis of them, and the troubles sometimes encountered in their use were set forth in this chapter for 1913. In addition, attention should be called to the results of certain tests on the melting point of alumina, bauxite, and bauxite brick made at the United States Bureau of Standards.[1] According to these tests pure alumina was found to melt at 2,050° C., but none of the bauxite brick examined approached this melting point. A sample of bauxite was tested and found to melt completely at 1,820° C., the centers of the nodules melting at 1,790°. A sample of bauxite clay melted at 1,795° C. In one sample of bauxite the melting point, after previous heating for six hours, varied from 1,730° C. to 1,740° C.; without previous heating, it varied from 1,740° C. to 1,745° C. In eight samples of bauxite brick the melting point varied, without previous heating, from 1,565° C. to 1,785° C.

4. Bauxite is used on a large scale at Niagara Falls in the manufacture of the artificial abrasive, alundum. This abrasive is made in the electric furnace by fusing calcined bauxite. It is high in crystalline aluminum oxide and virtually amounts to a form of artificial corundum. The quality of the product is under complete control and can be duplicated with ease for use in the various abrasive processes, a factor of great importance in any successful abrasive industry. Alundum is particularly efficient in the grinding of steel.

5. Lastly should be mentioned the application of bauxite in the manufacture of calcium aluminate to give a quick set to plasters. For a full description of the use of bauxite in calcium aluminate the reader is referred to Mineral Resources for 1911.[2]

METHODS OF PREPARING PURE ALUMINA FROM BAUXITE.

The two processes of manufacture which have transformed the metal aluminum from a chemical curiosity to a commercial commodity—the Hall and the Héroult processes—were patented in America and Europe about the same time (1888 and 1886). The alumina is prepared from bauxite in as pure a state as possible, and it is subjected to electrolytic reduction. The practical working details as carried out at Niagara Falls at the present time are not generally known, but the main features of the Hall process, as operated at Niagara Falls in the nineties, have been described by J. W. Richards.[3] Important modifications in the process of manufacture in recent years have been made in the methods of preparing the pure alumina from bauxite. It has been found that the degree of purity of the metal separated in the electrolytic bath is largely dependent upon the absence of impurities, chiefly silica and iron. Much care, therefore, is now given to this part of the manufacture.

Before bauxite is used in the preparation of metallic aluminum it is subjected to a process of purification to rid it of the associated silica. The reason for this is that otherwise the impurities present are reduced during the electrolytic treatment and pass into the metal, thus lowering the grade of the product and at the same time adding to the expense of the operation. Hence it is necessary in both the

[1] Kanolt, C. W., Melting points of fire bricks: Bur. Standards Tech. Paper 10, June, 1912.
[2] Phalen, W. C., Bauxite and aluminum: U. S. Geol. Survey Mineral Resources, 1911, pt. 1, p. 931, 1912.
[3] Richards, J. W., Aluminum, its history, occurrence, properties, metallurgy, and applications, including its alloys, 3d ed., Baird & Co., Philadelphia, 1896.

Hall and the Héroult processes to use the alumina in as pure a form as possible.

The Bayer process for the purification of bauxite has found wide application. In this process the ore is fused with either sodium carbonate or sodium sulphate and the fused mass is then lixiviated. The sodium aluminate obtained in solution is next decomposed by adding aluminum hydrate with constant stirring. According to J. W. Richards,[1] the decomposition proceeds until the quantity of alumina which remains in solution is to the sodium oxide as 1 to 6. This precipitation proceeds in the cold and the precipitated aluminum hydrate is readily soluble in acids. The solution which remains is evaporated, treated with ground bauxite, dried, calcined, and fused; and the operation is repeated.

Charles M. Hall has patented the lime process of wet chemical treatment (U. S. patent No. 663167, Dec. 4, 1900), which was installed at East St. Louis, and a process in which the bauxite is mixed with a small percentage of carbon and calcined, after which it is again mixed with about 8 to 10 per cent of carbon, some ferric oxide, and possibly some flux. Such impurities as iron oxide and silica are reduced, forming ferrosilicon of impure grade, which sinks to the bottom of the electric furnace and leaves the purified alumina at the top. After the alumina has cooled it is separated from the ferrosilicon by electromagnetic methods if necessary. In the patent specifications it is stated that aluminum powder is also added, but this is now thought not to be necessary. In England the British Aluminum Co. (Ltd.) purifies bauxite by dissolving it in caustic soda and precipitating the alumina by the addition of some previously precipitated alumina.[2]

McCulloch process.—One of the recent patents having to do with the preparation of pure alumina is that of Gilbert McCulloch (patent No. 941799, Nov. 30, 1909), from the text of which the following quotation is taken:

> McCulloch discovered that in the process of precipitation, alumina is precipitated first, and that the silica is mainly precipitated at the end of the operation, and that by arresting the precipitation before it is completed the bulk of the silica may be retained in solution along with a portion of the alumina and sodium carbonate and may be run back to the digesters for treatment with additional bauxite and caustic lime. The silica which is thus returned with the sodium carbonate liquor to the digesters does not accumulate in the liquor, but acts as the silica which is introduced as an impurity with the bauxite. The great bulk of the silica present, namely, that which is in the solution and that which is introduced with the bauxite, remains in undissolved form with the undissolved portions of the bauxite and calcium carbonate, if lime is used, and constitutes what is known as red mud. * * *
>
> The following table shows approximately the ratio at which the alumina and silica precipitate where the original solution contains approximately 0.25 gram of silica per liter:
>
> *Proportionate precipitation of alumina and silica.*
>
> When 50 per cent of alumina has been precipitated, 4 per cent of silica has been precipitated.
>
> When 75 per cent of alumina has been precipitated, 8 per cent of silica has been precipitated.
>
> When 80 per cent of alumina has been precipitated, 12 per cent of silica has been precipitated.

[1] Richards, J. W., Aluminum, its properties, metallurgy, and alloys, 3d ed., p. 144, 1896.

[2] Lyon, D. A., and Keeney, R. M., The smelting of metals in the electric furnace: U. S. Bur. Mines Bull. 77, p. 74, 1914.
Clacher, William, London Elec. Rev., vol. 68, p. 99, 1911.

When 87 per cent of alumina has been precipitated, 25 per cent of silica has been precipitated.

When 94 per cent of alumina has been precipitated, 80 per cent of silica has been precipitated.

When 100 per cent of alumina has been precipitated, 100 per cent of silica has been precipitated.

With a liquor containing more silica, the ratio tends to lessen earlier in the reaction, while in a liquor containing less silica the ratio tends to lessen later in the reaction. From the silica content of the liquor one is enabled to determine just when to stop the precipitation to obtain any degree of purity desired from the silica standpoint.

The above simply serves as an example, as with solutions containing more silica the precipitation would be stopped earlier, and with solutions containing less silica the precipitation may be continued until a larger proportion of alumina is precipitated.

Instead of filtering the aluminum hydrate and running the liquor back to the digesters to take up a new charge of alumina from bauxite, the liquor containing a small proportion of alumina may after filtration be run back to the agitators or to other agitators and the precipitation completed by means of CO_2 gas, giving an inferior grade of aluminum hydrate which would be useful for some purpose.

Lecesne process.—N. Lecesne has patented a mechanical method for removing most of the impurities from bauxite (French patent No. 424514, dated Dec. 31, 1910). The bauxite, after being air dried or dried by heating, is disintegrated in any form of apparatus in which it is subjected to impact, as contrasted with grinding or crushing. The dust which contains most of the ingredients other than alumina is eliminated as produced or subsequently by means of a fan, leaving a granular concentrate rich in alumina. In order to get rid of iron more completely, the bauxite may be dried by heating in a reducing atmosphere of 350° or 400° C., and the magnetic oxide thus produced may be separated electromagnetically. As an example, bauxite containing 3 per cent of silica and 60 per cent of alumina may thus be made to yield a concentrate containing less than 1 per cent of silica and as much as 86 per cent of alumina.

Serpek process.—The Serpek process deals primarily with the fixation of nitrogen. It involves also the production of alumina as a by-product, and hence is of interest in the present report. This by-product will probably prove of importance to the commercial success of the process. The raw material is bauxite, and thus the process involves a purification of this mineral. The pure alumina formed by this process is not used again in the fixation of the nitrogen, as it requires a higher temperature to combine with nitrogen than bauxite. The reaction is $Al_2O_3 + 3C + 2N = 2AlN + 3CO$.

In the experiments which Serpek carried out he found that at temperatures of 1,800° to 1,850° C. alumina, when mixed with carbon and subjected to an atmosphere of nitrogen, rapidly formed aluminum nitride, and that compounds such as bauxite would give the reaction at a slightly lower temperature. In practice he uses two rotating cylindrical kilns into the upper part of which bauxite is fed and calcined. In the passage from the upper to the lower kiln the bauxite is mixed with carbon, and in its passage through the lower kiln it passes an electrical resistance by means of which the temperature is maintained at 1,800° to 1,900° C. The nitride which is produced here is discharged into an air-tight chamber. The nitrogen which brings about the reaction is produced in a gas producer, and the mixture of nitrogen and carbonic oxide there evolved passes in the opposite direction to the descending material. The carbonic oxide is subsequently mixed with air and is burned in the upper kiln, effecting thereby the calcination of the bauxite. Contact of the

aluminum nitride with water produces ammonia and alumina, and in practice aqueous solutions of acid would be used for producing a soluble form of ammonium compound. It will be observed, therefore, that the process yields a pure alumina suitable for the manufacture of metallic aluminum and an ammonium fertilizer, the nitrogen in which is drawn from the stmosphere.

ALUMINUM.

PRODUCTION.

The magnitude of the aluminum industry is shown in the following table, which gives the production since the beginning of the industry in 1883 and the domestic consumption of the metal since 1904.

Production of aluminum in the United States, 1883–1914, in pounds.

1883	83	1895	920,000	1906	[1] 14,910,000
1884	150	1896	1,300,000	1907	[1] 17,211,000
1885	283	1897	4,000,000	1908	[1] 11,152,000
1886	3,000	1898	5,200,000	1909	[1] 34,210,000
1887	18,000	1899	6,500,000	1910	[1] 47,734,000
1888	19,000	1900	7,150,000	1911	[1] 46,125,000
1889	47,468	1901	7,150,000	1912	[1] 65,607,000
1890	61,281	1902	7,300,000	1913	[1] 72,379,000
1891	150,000	1903	7,500,000	1914	[1] 79,129,000
1892	259,885	1904	[1] 8,600,000		
1893	333,629	1905	[1] 11,347,000	Total	456,866,779
1894	550,000				

The secondary aluminum produced in 1914 was 4,522 short tons; the quantity of recovered aluminum contained in alloys was 1,731 short tons.

PRODUCTION IN FOREIGN COUNTRIES.

The following table shows the production of metallic aluminum in foreign countries for the five-year period 1909–1913:

Production of metallic aluminum in foreign countries, 1909–1913, in metric tons.[a]

	1909	1910	1911	1912	1913
Canada	[b] 2,800	[b] 3,500	[b] 2,300	[b] 8,300	[b] 5,900
Germany					
Austria-Hungary	5,000	8,000	8,000	12,000	12,000
Switzerland					
France	6,000	9,500	10,000	13,000	18,000
England	2,800	5,000	5,000	7,500	7,500
Italy	800	800	800	800	800
Norway	600	900	900	1,500	1,500
Total	18,000	27,700	27,000	43,100	45,700

[a] Metallgesellschaft (Frankfurt-am-Main), July, 1914, p. 16.
[b] Export.

[1] Consumption. The figures for 1914 do not include the weights of imported leaf aluminum, valued at $702; table, kitchen, and hospital utensils, and other similar hollow ware, valued at $528,778; wire, valued at $1,564, and "All other manufactures" of aluminum, valued at $191,170.

CONSUMPTION OF METALLIC ALUMINUM IN FOREIGN COUNTRIES.

The following table shows the consumption of metallic aluminum in foreign countries in 1909–1913:

Consumption of metallic aluminum in foreign countries, 1909–1913, in metric tons.[a]

	1909	1910	1911	1912	1913
France	5,000	5,400	5,000	6,000	7,000
England	2,000	2,700	3,000	4,000	5,000
Italy	800	900	900	1,000	1,000
Germany, Austria-Hungary, Switzerland, Russia, and other countries	12,000	13,500	17,000	22,100	21,000
Total	19,800	22,550	25,900	33,100	34,000

[a] Metallgesellschaft (Frankfurt-am-Main), July, 1914, p. 16.

EXPORTS.

The value of the exports of aluminum and of the manufactures of aluminum of domestic production for the last five years has been as follows:

Exports of aluminum of domestic production, 1910–1914.

1910	$949,215	1913	$966,094
1911	1,158,603	1914	1,546,510
1912	1,347,621		

RELATIVE ABUNDANCE OF ALUMINUM.

Aluminum is the most abundant of the metals. Among the elements which compose the crust of the earth it ranks third, being exceeded by oxygen and silicon alone. Alumina (Al_2O_3) in the proportion of 14.97 per cent has been found as the result of 1,075 analyses of igneous rocks made in the laboratory of the United States Geological Survey. This proportion of alumina corresponds to 7.98 per cent of the metallic element aluminum. The metal is an important constituent of all the common rocks except certain sedimentary rocks like sandstone and limestone, and even in these its compounds are often present as accessories or impurities.

Aluminum is never found in the elementary form, but always in combination as the oxide, hydrous oxide, fluoride, phosphate, sulphate, silicate, and so on. The most important ore of aluminum is the mineral bauxite, which is the hydrous oxide, having essentially the symbol $Al_2O_3.2H_2O$ and containing 73.9 per cent alumina and 26.1 per cent water. Some of the Arkansas ore is considered to correspond more closely to the mineral gibbsite, which has the symbol $Al_2O_3.3H_2O$ and which, in its pure form, contains 65.4 per cent alumina and 34.6 per cent water. It is quite probable that much of the aluminum ore mined consists of a mixture of both these minerals, though it is most commonly referred to as bauxite, which contains 39.2 per cent of aluminum on the basis of a content of 73.9 per cent of alumina, as stated above. Most of the commercial ore now mined contains from 50 to 60 per cent of alumina, which corresponds to a content of 26.5 to 31.8 per cent of metallic aluminum.

METHODS OF PRODUCING METALLIC ALUMINUM FROM BAUXITE.

Hall process.—Practically all the aluminum produced in the United States is obtained by the Hall process. The ore (bauxite) is first purified. The processes chiefly if not wholly employed in this country are those in which caustic soda or sodium carbonate is used. So far as known no sodium sulphate is used at all. The bauxite, previously ground, is digested with caustic soda by means of steam under pressure, as a result of which sodium aluminate is formed. The solution is filtered, diluted, run into high tanks, and agitated with alumina. The purified alumina is then charged into vats containing a bath of cryolite and fluorite. Both of these substances must be as free from silica and other impurities as possible. If this precaution is not taken, the silica is reduced to silicon which not only contaminates the resulting product but also consumes electrical energy. The vats or baths in which the reduction takes place are made of sheet metal, and are elongated, shallow affairs. A number of electrodes are introduced into the bath, and during the reaction carbon dioxide and some fluorine gas are given off. An extremely low voltage but very high amperage are necessary to perform the reduction. The electrodes are made of the purest carbon which is obtained from petroleum charcoal. The charcoal is mixed with magnesite and the mixture is forced into the desired shape through a hydraulic press. The electrodes are fitted to metal rods which hold them in place during the reduction. The reduction is continuous except during the time of pour. During the remainder of the day the alumina has to be fed in as it is required. The metal is poured through a hole in the bottom of the furnace into a pot and is remelted before being cast into ingots.

Tone process.—F. J. Tone (U. S. patent No. 961913, June 21, 1910) describes a process for the reduction of aluminum ore as follows: In the first step aluminum ore is reduced with the proper amount of carbon to aluminum carbide, which in the second step is used as a reducing agent in place of carbon for the reduction of ores of various elements to alloys of aluminum with these elements, or for the reduction of aluminum ores to metallic aluminum. For example, in the manufacture of a silicon-aluminum alloy corresponding to the formula 8Al.3Si, aluminum carbide and silica are taken in the proportion expressed by the chemical equation $2Al_4C_3 + 3SiO_2 = 8Al.3Si + 6CO$. The materials are subjected to heat in the electric furnace, and the silicon-aluminum alloy results. If the element aluminum is to be obtained as a final product, a mixture of aluminum carbide and aluminum oxide is made in accordance with the equation $Al_4C_3 + Al_2O_3 = 6Al + 3CO$.

SOURCES OF ALUMINA AND ALUMINUM OTHER THAN BAUXITE.

ALUNITE AS A SOURCE OF ALUMINA AND ALUMINUM.

A study of the alunite deposits near Marysvale, Piute County,[1] and Beaver, Beaver County, Utah, and in other parts of the Western States by the United States Geological Survey indicates that the mineral alunite may become at some future time a source of alumina.

[1] U. S. Geol. Survey Bull. 511, 1912.

The mineral alunite is a hydrous sulphate of aluminum and potassium, having the formula $K_2O.3Al_2O_3.4SO_3.6H_2O$. In its pure condition it contains 11.4 per cent of potassa (K_2O), 37 per cent of alumina (Al_2O_3), 38.6 per cent of sulphuric anhydride (SO_3), and 13 per cent of water (H_2O). The theoretically pure alunite is of rare occurrence in nature, but the analyses of that found near Marysvale, Utah, show that it approaches the composition of the pure mineral.

Attention has recently been attracted to alunite as a source of potash, but the experiments on it have shown that, though sulphate of potassium may be obtained from it, it is not to be ignored as a source of alumina. The experiments of W. T. Schaller [1] in the laboratory of the United States Geological Survey showed that—

On igniting the powdered alunite all of the water and three-quarters of the sulphuric acid are volatized. On leaching the residue with water the potassium sulphate is dissolved, leaving the insoluble aluminum oxide behind.

The average amount of potassium leached from the ignited mineral powder is 17.9 per cent of the original material used. As the coarsely crystallized alunite was found to contain 19.4 per cent of potassium sulphate, 92 per cent of the total potash present was obtained by simple ignition and subsequent leaching.

It is worth noting that, according to the laboratory experiments, 32.7 per cent of the ignited alunite consists of available potassium sulphate, which can be extracted by simple water leaching and evaporation. The remaining 67.3 per cent consists of nearly pure aluminum oxide.

One group of deposits of alunite is located about 7 miles south of Marysvale, which is the present terminus of the San Pete & Sevier branch of the Denver & Rio Grande Railroad, near the head of Little Cottonwood Canyon, in and near sec. 16, T. 28 S., R. 4 W. The deposit ranges in elevation from 11,000 feet above sea level to 9,900 feet at its lower end, which is about 4,000 feet above the railroad at Marysvale station. Other deposits are located 9 miles northeast of Beaver.[2]

The mineral occurs principally in the form of wide banded veins. The vein material occurs in massive form and has in part a porcelain-like appearance, varying in color from white through various shades of pink to red.

The working of the alunite deposits of Utah for potash salts may be expected to contribute to some extent at least to the alumina resources of the United States. Whether it can compete with bauxite in the Eastern States is a question; but as an offset to the freight charges from Utah to Mississippi River stands the fact that the alumina produced from high-grade alunite will presumably be so pure as not to require the chemical treatment which the bauxite of the Southern States has to undergo before reduction to metallic aluminum. Moreover, the alumina from alunite would be a by-product in the production of the more valuable potassium sulphate.

Besides the deposits of alunite in Utah, which seem to be the largest known at the present time in the United States, extensive deposits of the mineral are known to occur in the Rosita Hills, Colo. These were the first extensive deposits to be noted in the United States, and a report on the region, accompanied by a geologic map, was published in 1896.[3] Other Colorado deposits are in the Rico Mountains, at

[1] U. S. Geol. Survey Bull. 511, 1912, p. 58.

[2] For description of recently studied alunite deposits in Utah, see Potash salts: U. S. Geol. Survey Mineral Resources, 1914, pt. 2, pp. 21–23, 1915.

[3] Cross, Whitman, Geology of Silver Cliff and the Rosita Hills, Colorado: U. S. Geol. Survey Seventeenth Ann. Rept., pt. 2, pp. 263–403, 1896. Emmons, S. F., The mines of Custer County, Colo.: Idem, pp. 405–472.

Silverton, and at Cripple Creek. Other important occurrences in the Western States are at Goldfield, Nev.; at Tres Cerritos, Cal.; and in the Clifton-Morenci district, Arizona.

The foreign occurrences of alunite are very numerous; but the mineral has been worked abroad only at Tolfa, Italy, about 35 miles northwest of Rome, and near the village of Bullah Delah, county of Gloucester, New South Wales, Australia. At both these places the mineral is used chiefly in the manufacture of alum.[1]

PROCESSES OF DERIVING ALUMINA AND ALUMINUM FROM CLAY AND OTHER MATERIALS.

In the following pages are summarized what appear to be the more important processes patented during the last five or six years and having as their object, in part at least, the derivation of alumina and hence of the metal aluminum from raw material other than bauxite. In these pages are brought together for reference notes that have been published in this chapter during the last five years.

Though bauxite deposits are found from time to time and though the present demand does not appear to tax unduly the known supply, attention should be called to the interest now taken in the preparation of pure alumina from clay or other silicate minerals. As soon as a process for the extraction of alumina from clay is put on a commercial basis, low-grade bauxite containing considerable admixtures of clay will become available. That there is a large quantity of such material associated with most of the southern Appalachian bauxite is well known. This material should first be experimented with before the nonbauxitic clays containing the lowest proportion of alumina are utilized.

The years 1909 to 1914 were years of progress in the aluminum industry taken as a whole, but particularly so in that branch of the industry having to do with processes of manufacture and with new applications of the metal. Many inventions were patented relating to the metallurgy of aluminum and to its use in alloys.

The expiration of the aluminum-process patents and the great increase in output of metallic aluminum have given occasion to many scientific researches and commercial inquiries regarding new methods of producing metallic aluminum. These inquiries are appropriate in view of the fact that bauxite is found in comparatively few places, must be transported long distances, and contains so much silica as to require costly chemical operations to purify it in the manufacture of metallic aluminum. Aluminum silicates, on the other hand, are found almost everywhere, and the separation of the silica from them may at some future time not cost more than to counterbalance the scarcity, inaccessibility, and impurities of the bauxite deposits.

Tone process.—Among the interesting inventions involving the derivation of alumina from sources other than bauxite is a group patented in December, 1908, by F. J. Tone, which have for their object the production of silicon from kaolin and the formation of pure alumina as a by-product. Calcined kaolin (clay) is mixed with carbon in the electric furnace. Under proper regulation of the heat the silica is reduced, which results in the production of elementary silicon; iron oxide, if present, is also reduced to metallic iron, and titanium oxide

[1] U. S. Geol. Survey Bull. 511, pp. 51–57, 1912.

is reduced to metallic titanium. The alumina thus purified from metallic oxides remains behind unreduced. If iron is mixed with the charge, ferrosilicon is obtained. The reactions reduced to their simplest forms are as follows:

$$Al_2O_3.2SiO_2 + 4C + Fe = Al_2O_3 + FeSi_2 + 4CO$$
$$Al_2O_3.2SiO_2 + 4C = Al_2O_3 + 2Si + 4CO$$

According to Tone, the silicides produced in the process are useful for various purposes, such as the refining of iron and steel, and the alumina is useful as an abrasive and also for the production of metallic aluminum.

Sinding-Larsen process.—Further work along the line of the production of silicon from kaolin and the formation of pure alumina as a by-product has been done by A. Sinding-Larsen (patent No. 927758, July 13, 1909), who proposes to treat silicates of alumina like feldspar, clay, and kaolin in the electric furnace in contact with scrap iron, or iron ore, and coke. As a result of the treatment a layer of fused ferrosilicon is formed at the bottom and slag containing aluminum oxide at the top. This aluminum oxide may be further treated in the preparation of metallic aluminum.

Moldenhauer process.—In Metallurgie for January 8, 1911, Max Moldenhauer concludes, from several electric furnace experiments, that the question of the use of silicates in the manufacture of metallic aluminum has been practically solved. The mixture of aluminum silicate with iron ore and carbon in the electric furnace produces ferrosilicon and an alumina slag that contains only a very little silica and iron oxide. The slag may be pulverized, the globules of ferrosilicon removed by magnetic separation, and the alumina used in preparing metallic aluminum.

Betts process.—Among other new methods recently patented for the preparation of metallic aluminum is one by A. G. Betts (patent No. 938634, Nov. 2, 1909). Betts proposes to use iron and aluminum ore, the latter in the form of either bauxite or clay. These ores are charged with fuel into a blast furnace, which differs from the ordinary furnace in that a higher temperature is used in the smelting section of the furnace. During the smelting process silicon is formed and there results an alloy of iron, aluminum, and silicon. The alloy may then be treated with iron sulphide, the reaction being carried out in two stages. The aluminum sulphide which is formed is converted by electrolysis into aluminum and sulphur.

Cowles process.[1]—Two processes were patented in 1912 for the extraction of alumina from clay, and other patents having for their object the extraction of potash salts and alumina from such silicates as the feldspars were taken out in 1912. The two processes may be named the Cowles process and the Childs process, from their inventors, Alfred H. Cowles and David H. Childs.

In the Cowles process clay, carbonaceous matter in the form of either charcoal or sawdust, and salt are made into perforated briquets, which, after being dried in a kiln, are passed in flat cars through a long furnace where their temperature is raised to about 1,035° C. Steam is blown into the discharge end of the furnace, while through

[1] Original communications: Eighth Internat. Cong. App. Chemistry, vol. 25, pp. 119–124. See also patents Nos. 1040892, 1040893, 1040894, 1040895, and 1040977, all dated October 8, 1914.

the other end the loaded cars are gradually moved forward by a hydraulic pusher. The speed is under control. The weight and composition of the material on the cars is known and the correct quantity of exhaust steam is passed into the furnace from the opposite end. The gases are sucked from the charging end and forced through a condensing system. The reaction which occurs varies according to the composition of the mixture, but sodium silico-aluminate and hydrochloric acid are the valuable products formed. The latter is condensed and saved. Any iron present in the clay is condensed as iron chloride in the first condenser of a multiple series system. The acid produced is very pure. When briquets containing 32 per cent sodium oxide are used the output of 30 per cent acid should be about 1½ tons per ton of salt and clay charged into the furnace.

The sodium silico-aluminate, which is acid in reaction, is next treated to obtain from it the sodium aluminate. The calcined briquets are ground and treated with enough lime to combine with silica to form dicalcium silicate. The chemical equivalent of limestone, calcite, or marl may be used instead of anhydrous lime. The mixture of lime and acid is heated in a furnace just to the clinkering temperature. On being discharged it is broken up and leached. Nearly all the sodium aluminate may be leached from the clinker; the residue is a white mass of dicalcium silicate containing some sodium aluminate. The method of procuring alumina and caustic soda from the solution is the one in general use. The dicalcium silicate with one molecular weight more of lime is used in white cement mixtures.

The process outlined opens the way to obtain alumina cheaply or as a by-product of other products which are consumed on a large scale in the industries. Cowles believes that with the introduction of the process the cost of production of metallic aluminum will be reduced 4 or 5 cents a pound.

Childs process.[1]—The Childs process consists of producing aluminum fluoride, which when calcined in the presence of water or water vapor produces alumina (Al_2O_3) as a solid and hydrofluoric acid (HF) as a gas. Hydrofluoric acid gas, or some other volatile compound of fluorine—for example, silicon fluoride—is passed through kaolin (clay) kept moist by a steady flow of water. The water dissolves the gas, forming a dilute solution of it which attacks the kaolin, the aluminum in it passing over into aluminum fluoride, which is dissolved in the water. The acid gas removed from the water allows the latter to take up more gas; thus more aluminum fluoride is formed, and there eventually results a strong solution of this compound. When the solution is evaporated the aluminum fluoride is left in the form of crystals. The crystals may then be calcined to produce alumina, and the process may be repeated with the hydrofluoric acid gas which passes off during calcination.

In the second patent (No. 1036454) a process is described in which an aluminum silicate is mixed with aluminum fluoride and heated so that the fluorine reacts upon the silica, producing a volatile compound of fluorine and silicon, and leaving alumina. The silicon fluoride

[1] Action of some fluorine compounds on clay, water, etc.: Eighth Internat. Cong. App. Chemistry Original Communications, vol. 2, pp. 67–74; vol. 25, pp. 215–218. Also patents Nos. 1036453 and 1036454, dated Aug. 20, 1912.

may then be passed through a compound of aluminum kept moist by a steady flow of water, with which it will combine, forming hydrated silicon oxide, which will precipitate and leave a dilute solution of hydrofluoric acid, or hydrofluosilicic acid, or both.

The reactions may be expressed thus:

$$SiF_4 + 4H_2O = H_4SiO_4 + 4HF;$$

$$2SiF_4 + 4H_2O = H_2SiF_6 + 2HF + H_4SiO_4.$$

The hydrofluoric acid and the hydrofluosilicic acid thus formed will attack the aluminum compound and will produce aluminum fluoride in the way already described above. If the aluminum compound is clay or kaolin ($Al_2O_3.2SiO_2$), the reactions may be expressed thus:

$$6HF + 2SiO_2.Al_2O_3 = 2AlF_3 + 2SiO_2 + 3H_2O;$$

$$H_2SiF_6 + Al_2O_3.2SiO_2 = 2AlF_3 + 3SiO_2 + H_2O.$$

In carrying out the process approximately four pounds of aluminum fluoride is required for each pound of silica, whether free or combined, contained in the material used. The details of carrying out the process are explained in the text of the patent.

Peacock process.—During the last few years great interest has attached to the methods having as their object the extraction of potash salts from the feldspars, chiefly or in general from the silicate rocks containing 10 per cent or more of potassa. Such minerals and rocks generally contain alumina in appreciable quantities, and many of the processes described mention alumina as one of the valuable products formed, usually in a pure state.

One of these processes has been patented by Samuel Peacock (U. S. patent 1035812, dated Aug. 13, 1912). In this process feldspar is coarsely ground and then heated with carbonate of lime. The calcined mixture is pulverized through a 100-mesh sieve and enough soda or potash is added to furnish one chemical equivalent for each chemical equivalent of alumina present. The mixture is then boiled, preferably under pressure with sufficient water to make a thin paste. The alumina is rendered soluble as an alkali aluminate, the silica remaining insoluble as calcium silicate. The soluble and the insoluble materials are separated by filtration, and the alumina is recovered by passing carbon dioxide through the solution. All the alkali can not be separated from the aluminate by this method and its presence in the alumina unfits the latter for certain uses. To remove the alkali, the alumina is carefully sampled and its content in alkali and silica is determined. There is then added enough amorphous silica to make with that already present one equivalent for each equivalent of soda or potash in the crude alumina. The mixture is treated in a digester by superheated steam at a pressure of five atmospheres, so that all the insoluble alkaline aluminate is decomposed. The material is filtered while hot and the precipitate is washed. Silica and alkali are removed as alkaline silicates and alumina is left practically pure.

Kissock process.—Alan Kissock has patented a process (U. S. patent No. 1052727, Feb. 11, 1913) for extracting aluminum from its ores, of which the silicate is taken as an example, as follows: The charge consists of a mixture of any suitable aluminum-bearing

material containing enough carbon to convert the aluminum to the carbide and the proper quantity of some sulphur compound or sulphur to convert the aluminum carbide to the sulphide. This charge is put into an electric furnace of suitable design and heated. The resulting aluminum compound is separated, dissolved, and electrolyzed in a molten bath of alkaline earth chlorides or fluorides, and the resulting metallic aluminum is drawn off.

A particular aluminum compound as well as other specific ingredients, together with the proper proportions for mixing them are described in the patent, though stress is laid on the point that the invention is not limited to these proportions of these ingredients. For example, the charge may consist of an intimate mixture of aluminum silicate or carbon in the form of coke. This charge is placed in an electric furnace of suitable design and heated to a temperature of about 3,500° C. The aluminum carbide formed is separated from the rest of the mass and heated with sulphur. The resulting aluminum sulphide is then dissolved and electrolyzed in a molten bath of alkaline-earth chloride or fluoride and the resulting aluminum is drawn off. An alternative charge consists of an intimate mixture of aluminum silicate, carbon in the form of coke, and calcium sulphide. This charge is heated to a temperature of about 3,500° C. in an electric furnace and the aluminum sulphide formed is separated, dissolved, and electrolyzed as before. The proportions of the ingredients used and the reactions resulting are given in the text of the patent.

ALUMINUM INDUSTRY.

SOUTHERN ALUMINUM CO.[1]

During the greater part of 1914 the Southern Aluminum Co. was actively engaged in pushing its extensive operations at the narrows of Yadkin River, near Whitney and Badin, Stanley County, N. C. As a result of the European war, however, the development by the Southern Aluminum Co. is practically at a standstill for an indefinite period. The entire plant is now in charge of caretakers and is being given the best possible protection against deterioration during the shutdown, the length of which it is difficult to foresee.

This extensive project for the manufacture of metallic aluminum and the adjuncts that are necessary for its manufacture have been described in this chapter in previous years. To recapitulate briefly: The work in progress consists of a hydroelectric installation of great size for the generation of electric power; an elecrolytic plant of large capacity for the production of metallic aluminum; works for purification of alumina; an electrode factory; and the homes and other buildings necessary for the well-being of the large number of employees engaged in an important undertaking of this kind.

Early in 1913 a contract was let to the Hardaway Contracting Co., of Columbus, Ga., to build a concrete dam and power house, to drive tunnels, and to grade sites for the electrolytic plant. The contractors immediately had extended for their needs the branch railroad built from Whitney, where a connection is made with the Southern Railway and the Winston-Salem Southbound Railway. Track was laid through the narrows and a steel bridge was built to give access to the east side of the river. By a series of switchbacks the higher levels along the river are reached and

[1] Hafer, Claud, Where white coal is to make white metal—The Southern Aluminum Co.'s developments at the narrows of the Yadkin River: Mfrs. Record, Aug. 13, 1914, pp. 47–49.

all parts of the works are thus served. At present there are 20 miles of standard-gage track, laid with 70-pound rails, within a radius of 1 mile from the dam site.

The dam is to be 220 feet high, 1,300 feet long, 160 feet thick at the base, and 20 feet at the crest. It will swing as the arc of a circle of 1,600 feet radius, and from 550,000 to 600,000 cubic yards of concrete will be used in its construction. This great dam will store water to generate from 20,000 to 70,000 kilowatts, according to water stage, and will form a pond of 5,000 acres. With the reservoir full, the river will be held in check for 5 miles along its course, and the old granite Whitney dam will be entirely submerged.

Twin tunnels just completed, 900 feet long and 40 by 34 feet cross section, will carry the river's flow during construction and the storm waters afterward. The spillway, which is to pass around the eastern end of the dam, will connect with the tunnels through the shafts, and gates at the upper portals will permit the drainage of the reservoir when desired. This work, now nearing completion, was done by subcontractors, who were furnished equipment and power by the Hardaway Co.

A rock-filled cofferdam is now being constructed, 60 feet high and 90 feet across; the excavations are being made for the foundation and abutments of the dam, and the placing of concrete for the wheel pits and power-house foundations is going on. The power house will be 60 by 600 feet, with its long axis paralleling the river's course; its equipment will include five double turbines of 15,200 horsepower, one of 7,600 horsepower, and two of 1,700 horsepower.

The generators will be General Electric—eleven 5,200-kilowatt 520-volt direct-current for metallurgical purposes and two 1,250-kilowatt alternating-current machines for mechanical purposes.

To carry on this work the contracting company has brought together a great quantity of equipment. This includes a crushing and concrete mixing plant designed to turn out 2,000 yards per 10-hour shift. There are also in use 33 steel derricks, each of 25-tons lifting capacity. To operate these derricks there are 33 special hoisting engines. There are also on the ground 2 locomotive cranes of 18 and 20 tons lifting capacity each; twenty 44-ton saddle-tank locomotives; fifty 12-yard steel dump cars; twenty-four 100,000 pounds capacity all-steel flat cars; ten 80,000 pounds capacity wooden flat cars; one hundred and fifty 3½-yard steel skips; fifty 2½-yard bottom-dump buckets; and 7 steam shovels of different capacities.

A power line from the Albermarle substation of the Southern Power Co. carried on steel towers transmits power for the work in progress. This is transformed partly into air power which supplies compressed air to operate the hoisting engines, rock drills, and the drill sharpening machines at the five different blacksmith shops. In addition to the blacksmith shops there are mechanical and wood shops where the forms are made.

The water supply for the locomotives and the compressor plant is taken from the river. Four hundred feet above the river at the brink of the gorge a site of 11 acres is being graded for the furnace buildings.

At Badin the buildings for electrode factory, warehouse, and machine shop are well under way. These buildings are of steel-construction. The main body of the electrode factory is 322 by 180 feet, and will contain the baking ovens. Each of the four bays has a crane runway, carrying a 5-ton Cleveland crane. An addition to the west end of the main house, 180 by 260 feet, will contain the machinery, kiln, and gas producers used in the manufacture of electrodes. The main bay of this addition is provided with a 20-ton Cleveland crane, having a 5-ton auxiliary lift. An elevated track at the rear will deliver raw material.

The machine shop consists of a main hall, 60 by 315 feet, with a 30-foot addition to the entire length of the south side. A 10-ton crane and railroad track through the main hall serve to handle material.

The cranes are operated electrically, and take power from a line coming from a 150-kilowatt hydroelectric plant built by the old Whitney Co., which also lights the town and operates the machine tools. The building for alumina purification plant has not yet been started, but it will be similar to those already erected, and about 500 by 500 feet in area. Railroad connection between the plants at Badin and the furnace site is over a 2-mile track that will carry the shipments of alumina and electrodes in and the metal out.

In all there were 2,500 men at work before the shutdown, but after production commences 1,200 or 1,500 men will be required.

ALUMINUM CO. OF AMERICA.[1]

The plant of the Aluminum Co. of America at Maryville, Tenn., began operations in March, 1914. Additional equipment is planned to follow the completion of the big hydraulic plant and dams to be constructed on Little Tennessee River. The Maryville plant is now using 35,000 horsepower, 25,000 of which is furnished by the East Tennessee Co.'s hydroelectric plant at Parksville, Tenn., and 10,000 by the Chattanooga & Tennessee River Power Co.'s plant at Hales bar, near Chattanooga.

The plant, 1 mile north of Maryville, is located between the tracks of the Southern and the Louisville & Nashville railways. The company has constructed a railroad 1 mile long from the Southern to the Louisville & Nashville tracks, and from this track it has extended spurs along each side of its warehouse and back past the ore bins for the purpose of unloading the ore and of weighing carloads of material. In addition, the Southern Railway has established a station opposite the plant, which is known as North Maryville.

The power house is 200 feet long, 60 feet wide, and 40 feet from the floor to the roof on either side. The foundations are constructed of concrete throughout, and the walls are of brick in a structural steel frame. The power house is so constructed that it can be extended as additional pot rooms are added to the plant. Practically every piece of machinery in the plant is electrical. The transmission wires for the operation of this plant are of aluminum, and are the product of the company's plant at Massena, N. Y.

The pot rooms, two of which are now in operation, are 450 feet long and 50 feet wide, and of about the same height as the other building. They extend west from the power house. Each pot room has 72 pots.

The ore bins are set on a concrete foundation about 12 feet high, and under them are extended tracks where tram cars are loaded and thence transferred to the pot rooms. The bins are of steel construction, 36 feet in diameter, about 125 feet high, and each holds 45 cars of ore. The cars are unloaded by an elevator run by a motor.

The relining building is 160 feet long and 50 feet wide; the walls on either side are 32 feet from floor to roof. The foundation is concrete and the walls are of brick. In this building are the relining shops; the blacksmith shops; the ovens for rebaking the pots after they are relined; and the 150-horsepower steam boilers used for the operation of the auxiliary plant, which is a few feet west and

[1] These notes on the plant at Maryville, Tenn., were abstracted from an article by L. P. Mason in Manufacturers Record, July 9, 1914, pp. 47–48.

connected with this building. These boilers are also used for steam heating during the winter months. This building is equipped with an electric traveling crane. The auxiliary plant, which is of 10,000-horsepower capacity, is never used, except in cases of emergency when the company is unable to get the necessary power from Parksville for electric lighting, for the machine shops, etc.

The warehouse is 500 feet long, and 110 feet wide. The walls are of brick with concrete foundations. The machine shops, the general offices, and the general supply house are in this building. The warehouse is parallel to the pot rooms and is connected with them by platforms and tramways over which the aluminum is transferred.

The Aluminum Co. of America is planning to erect a plant at Edgewater, N. J., in 1915, the land for which has been bought. Plans for the building and machinery are now being made. The Edgewater plant will be a sheet mill and stamping factory, where will be made sheet for the trade, cooking utensils, and other finished goods. The foil mill of the company, referred to in the report for 1913 as nearing completion, is reported to have begun work in the spring of 1914. The product of this mill is taking the place of aluminum foil, formerly imported, and in part of the tin foil which was formerly used in the wrapping of such commodities as chocolate, tobacco, and tea.

ALUMINUM MARKET.

The sequence of prices for No. 1 ingot aluminum in New York City during 1914 is given below. [1]

At the close of 1913 quotations on metallic aluminum were 18¾–19¼ cents a pound, with a weak market and but slight demand for the metal. During early January the market continued quiet with few sales and with prices stationary at 18½–19 cents. Toward the end of the month business improved slightly, but it was not especially active. At this time quotations were about 18¾–19 cents, with quotations on futures about the same. With the coming of February business seemed to improve slightly but quotations did not change during the first half of the month and tended slightly downward with few sales during the last half of the month. At the beginning of March business was extremely dull and prices were the same as in late February, namely, 18½–19 cents a pound. These prices were maintained well into March, but toward the end of that month, though competition for business seemed fairly keen, prices weakened a little to 18¼–18¾ cents. Small sales and a dull market obtained at the end of the month, which closed with the metal at 18–18½ cents. These prices held till nearly the middle of April when the market weakened slightly to 17¾–18¼ cents, but later became better remaining at 18–18½ cents during the remainder of the month. Business was quiet in early May with quotations at 18–18¼ cents. The market then became more active and sales were larger than for some time, the prices becoming slightly firmer at 18–18½ cents. As the middle of May approached, the market remained fairly active. There was some competition and imported metal was offered at lower figures. Prices weakened to 17¾–18¼ cents and at

[1] Quotations for 1914, and for the preceding years have been taken from the Engineering and Mining Journal.

the end of May they were about the same. Throughout June business remained quiet. In the first half of the month there was some competition, but toward the end of the month the demand was light and sales were on a small scale. The market during June ranged from 17½ to 18 cents. Through early July also the market continued quiet and sales were few, with quotations at 17½–18 cents. Though there were some inquiries in late July there was little increase in actual sales, and quotations at the end of the month were 17½–17¾. Sales as low as 17⅜ cents were reported.

At the outbreak of the war in Europe in early August foreign supplies of aluminum were cut off and no prices were quoted for foreign metal. Though domestic contracts were being filled, there were no quotations for new business and little was reported. Nominal quotations at this time were 19–20 cents. The market remained quiet as August advanced and quotations at the end of this month were 20–20½ cents. A quiet market obtained throughout September with quotations the same as at the end of August. At the beginning of October, with a quiet and dull market, quotations fell to 18½–19 cents, then to 18–19 cents, at which figure they continued throughout the month. Business remained quiet and unchanged with quotations at 18–18½ cents throughout the first half of November. At the end of the month the demand improved and the market was slightly more active. Quotations became slightly firmer at this time and were 19–19½ cents. December opened with a quiet market and with prices slightly below those of the end of November, namely at 18½–19 cents. Quotations held at approximately 19 cents until the end of the year.

The figures given in detail above are presented in concise form in the following table, and they are also represented graphically in the accompanying figure.

Average price of aluminum in ingot form in New York City in 1914, in cents per pound.

January	18¾–19	August, last part of month	19½–20¼
February	18⅝–19	September	20 –20½
March	18 9/10–18⅘	October	18 –19
April	17 9/10–18⅖	November	18¼–18⅞
May	17⅘–18½	December	18⅖–19
June	17½–18		
July	17½–17⅞		
August, first part of month	17½–17¾		

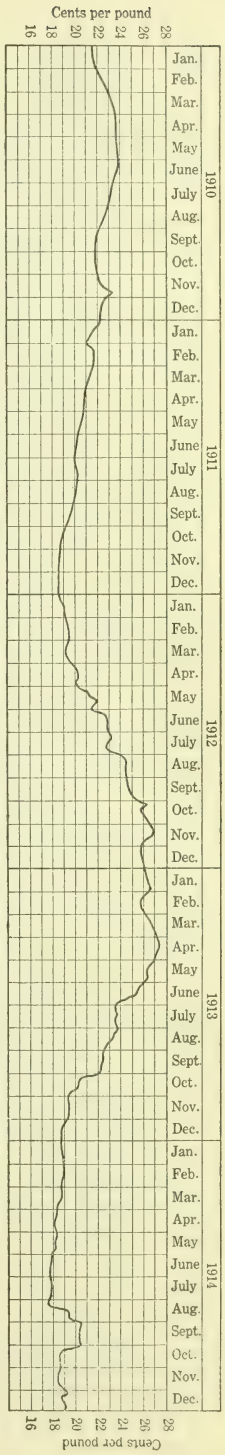

FIGURE 1.—Curve showing price at New York City, by months, 1910-1914, of metallic aluminum in the form of No. 1 ingots.

USES OF ALUMINUM.

One needs only to glance at the increasing consumption of aluminum, as indicated in the table on p. 191, to get an idea of its increasing use. The variety and extent of its possible uses may be inferred from a consideration of its properties. Its specific gravity is only 2.6 to 2.7 as compared with water taken as 1, while that of steel is 7.7 and that of brass more than 8. It possesses malleability, ductility, and considerable tensile strength. It alloys fairly easily with other metals and strongly resists the influence of iron, water, and vegetable acids. For these reasons it is being used on an increasing scale in making kitchen utensils, surgical appliances, jewelry, and fancy articles, and bearings for machinery.

Another use, relatively unexploited, is in the decoration of interiors; that is, in supplanting wood in modern business offices. About the only articles that are still made of wood in the modern office are the desks and chairs, and it is more than likely that these soon will be supplanted by metal in response to the requirements of fireproof construction and furnishings. Painted sheet steel is now a favorite material for interior construction, but aluminum will probably be found quite as satisfactory.

Aluminum is now used in ways which do not attract very much attention, but in which large quantities of the metal are consumed—for example, the manufacture of novelties, which has been referred to in this chapter for several years past.

Powdered metal, known as aluminum bronze powder, is used in painting, printing, and lithographing, as a constituent of explosives, and as a patented source of heat. A very modern use is as a casing for explosives. Aluminum foil, which has hitherto been largely imported, is now manufactured here and is meeting with considerable success. Perhaps one of the greatest advances made in 1914 has been in the quality of the aluminum sheet manufactured in the United States. Aluminum sheet has a tendency to blister and to show other surface defects, but special efforts have been made to study the cause and remedies for these defects. These efforts have been so far successful that the sheet on the market to-day is of very superior quality.

An investigation [1] has been made concerning the influence of aluminum on Bessemer ingots and rails when added to the molds during the pouring of the steel. The work was done at the South Chicago works of the Illinois Steel Co., which furnished the material. Five ingots were of untreated Bessemer steel; eight were treated with aluminum varying from 1 to 10 ounces per ton of steel, and two of these ingots were treated with additions of ferrosilicon, equivalent to one-tenth and two-tenths of 1 per cent of silicon, respectively. These latter were rolled into rails. In summing up the benefits resulting from the addition of aluminum, Wickhorst says:

> Ingots treated with aluminum added to the mold were of more even composition throughout than plain Bessemer steel. There was less positive segregation in the interior and upper parts of the ingot, but the negative segregation or soft center in the interior and lower parts of the ingot was about the same. There was a softening or negative segregation in the upper part of the wall of the plain ingot, while in the aluminum treated ingots the walls were of fairly even composition throughout the

[1] Wickhorst, M. H., Aluminum in rail steel: Iron Age, April 30, 1914, p. 1073.

height of the ingot. The aluminum treated ingots had larger and deeper pipes than the plain steel, but had denser steel around the pipes.

Rails of plain steel had a brittle zone in the upper part of the bar, as disclosed by the drop test. In the rails of the aluminum-treated steel this zone was largely eliminated. Rails of plain steel contained their laminations close to the top end of the bar, while in aluminum-treated rails the interior laminations were found a considerable distance from the top end, varying from about 30 to 45 per cent of the weight of the ingot. In the transverse test of the base, rails of aluminum-treated steel showed a considerably greater transverse strength of the base and sag of the flange before breaking than the rails of plain steel with 0.61 per cent carbon and a little greater strength and sag of flange [than rails] with 0.45 per cent of carbon.

In a pamphlet issued late in 1913 by the British Aluminum Co. (Ltd.), a very complete and frank statement is given of the advantages and limitations of the metal aluminum in construction on a large scale. When aluminum first began to assume considerable industrial importance, two disadvantages militated against its rapid extensions: First, the initial capital expenditure, and second, constructional difficulties in any but the smallest vessels. According to the information contained in the pamphlet, the difficulty of high first cost has been annulled by a considerable reduction in the cost per ton in recent years, made possible by improved and extended manufacturing facilities. In this connection, the fact should not be lost sight of that the upkeep charge is low on the metal, which is especially free from corrosion, heavy handling, and frequent scouring.

The temporary setback, due to constructional difficulties, has been effectively met by the introduction of the process of autogenous welding. The soldering of aluminum in a chemical plant is and has been unsatisfactory. It has at all times been a difficult and unreliable process, as it has introduced alloys of a different composition in the electro-chemical scale which have set up galvanic action with the resulting evils of electrolysis and subsequent corrosion. Aluminum does not lend itself to riveting, as its malleable nature and low yield point are serious obstacles to a sound and lasting joint where extremes of temperature and vibration are likely to be encountered; but by the process of welding, referred to above, aluminum vessels of any size or shape can now be made from the metal in its purest sheet form. It is stated that aluminum is suitable for practically all purposes in the chemical plant, provided it is not brought into contact with hydrochloric acid, halogen solutions, or caustic alkalies.

The better known branches of the chemical industry, in which aluminum vessels of large size are in use, are in the brewing industry; in the manufacture of varnish; in the preparation of foodstuffs, such as sirups, essences, and jams; in the refining of sugar; in the preparation of edible oils and fats, and of such fatty or vegetable acids as oleic, stearic, and palmitic acids. It is also used by the soap and candle manufacturers; in certain branches of the explosive industry; in the construction of certain parts of the dye-works plant; and to an increasing extent in the production of hydrogen peroxide and formaldehyde, citric acid, and glycerine, and a host of less-known chemicals.

ALLOYS.

W. H. McAdams (U. S. patent No. 1092500, dated April 7, 1914) has invented an aluminum alloy in which the metals composing it are preferably combined in the following proportions: Aluminum, 70 parts by weight; zinc, 26 parts; copper, 3 parts; and silver,

1 part. The object of the invention is to provide an alloy for casting which does not tarnish and which possesses great fluidity and strength. The alloy of the composition given has such a degree of fluidity that it takes the smallest indentation of the mold with great accuracy. Castings made from this alloy have the very desirable feature of being light and nontarnishable. They have a silver-like surface, and are sufficiently strong to be used in the great majority of cases where brass is now used. The alloy is also said to be capable of resisting acids and alkalies to such an extent as to make it desirable for general use. The small quantity of silver adds but little to its expense, but serves to make the alloy resistant to alkalies and to impart to it its silver-like color.

McAdams has patented other alloys of aluminum as follows: In the specifications of U. S. patent No. 1095653, dated May 5, 1914, an alloy consisting of 70 parts aluminum, 22 parts zinc, 3 parts copper, and 5 parts antimony by weight is described. The method of producing the alloy is also outlined. It is claimed that this alloy is especially well adapted for casting under pressure in die-casting machines; that it is very strong and resonant; and that it has a permanent superior luster.

In U. S. patent No. 1099561, dated June 9, 1914, McAdams describes an alloy consisting of 100 parts by weight of aluminum, 5 parts by weight of copper, and 2 parts by weight of silver. This alloy can be readily rolled into thin sheets, will not tarnish, and has a fair degree of stiffness and resiliency. The method of procedure in making the alloy is also described.

In U. S. patent No. 1121267, dated December 15, 1914, McAdams describes an alloy consisting of the following metals combined in the proportions indicated by weight: Aluminum, 100 parts; copper, 18 parts; zinc, 5 parts; and antimony, 3 parts. The method of producing the alloy is described. It is claimed that the alloy gives a very satisfactory casting metal and that the articles cast from it are very strong.

In U. S. patent No. 1121269, dated December 15, 1914, McAdams outlines a method of producing an alloy in which the metals are combined by weight in the following proportions: Aluminum, 100 parts; cadmium, 30 parts; and tin, 5 parts. The resulting alloy is very soft and is suitable for making metal foil.

Thomas A. Bayliss and B. G. Clark, of England, in United States patent No. 1117308, dated November 17, 1914, have patented improvements in alloys containing aluminum, zinc, and cadmium. The ingredients are present in the finished alloy in proportions between the limits of 80–99 per cent of aluminum, between 0.001–19.999 per cent of zinc, and between 0.001 and 10 per cent of cadmium. Methods of producing the alloy are described. In addition to increased strength it is found to be malleable and workable under all conditions and to have a smooth cast surface which may be readily machined. The metal, furthermore, is extremely strong and tough and is malleable and suitable for stamping and similar purposes, so that utensils and ornamental objects may be formed from it. It may be rolled into lengths, and strip wire may be formed from it.

The metals may be present in any proportion within the limits given above, but by way of example the compositions of two alloys are given as follows: (1) Aluminum 91 per cent, zinc 8 per cent, and

cadmium 1 per cent; (2) aluminum 88 per cent, zinc 10 per cent, and cadmium 2 per cent. Both of these alloys are strong and highly malleable when cast in chill molds for rolling. When cast in sand molds, the castings have a fine smooth surface and can be readily machined, turned, or screw-cut.

Charles P. Van Gundy (U. S. patent No. 1098137, dated May 26, 1914) has patented an alloy containing aluminum, zinc, and lead which, though adapted for general use where light, strong castings are required, is especially adapted for use where high temperatures exist, as, for example, in packing rings for pistons of locomotives using superheated steam. The metals mentioned above may be combined with a strengthening metallic constituent, such as copper or nickel or a combination of these two metals. The method of procedure in making the alloy is described and the different proportions of the metals that may be used are indicated. The percentage of the several elements which the patentee has found most efficient and economical are: Aluminum, 86.5 per cent; zinc, 9.7 per cent; lead, 2.5 per cent; and copper, 1.3 per cent.

SOLDER FOR ALUMINUM.

Auguste Cornaud and Henri Van de Cruys, both of Brussels, Belgium (U. S. patent No. 1092340, dated April 7, 1914), have patented a soldering and welding alloy for aluminum, made up of the following metals in the proportions indicated: Aluminum, 17.5 parts, zinc 52 parts, tin 30 parts, and nickel 0.5 parts. This alloy permits soldering and welding of aluminum to be carried out at very low temperature. It adheres firmly, and it can be used without acids or welding powders.

METHOD OF PURIFYING MOLTEN ALUMINUM.

Grenville Mellen (U. S. patents Nos. 1092935 and 1092936, dated April 14, 1914) has patented a process for purifying molten aluminum from such mechanically contained impurities as result from remelting scrap metal and from stirring the molten metal. The impurities consist chiefly of aluminum oxide, which when stirred into the molten metal is held there by virtue of its higher specific gravity.

Mellen's method consists in injecting into the molten bath a non-oxidizing material which boils at a lower temperature than the melting point of aluminum and which has also a lower specific gravity. The vapors of such material rising through the molten bath carry the impurities to the surface, where they react with a flux and may be removed. Sulphur has the property of combining with such impurities, either mechanically or chemically, and of carrying them to the surface. The addition of sodium chloride to molten sulphur—the mixture being thoroughly stirred and cast into rods—produces a material particularly adapted to accomplish the desired results. Instead of sodium chloride, sodium sulphide may be used. To the surface of the molten metal sodium metaphosphate or zinc chloride may be added. Both these substances fuse readily and combine with the salt and sulphur scoria or dross.

Mellen has found that—

> aluminum scrap from different sources, such as scrap sheet, turnings, and castings that have been corroded by use and exposure to air and water, and which, if melted without any purifying agent, would produce a very impure metal, will, upon being treated with the purifying agency * * * described, produce a metal equal in every way to new and hitherto unused metal.

PRODUCTION OF ALUMINUM SALTS.

The following table gives the domestic production, the imports, and the value of aluminum salts from 1910 to 1914, inclusive:

Production and imports of aluminum salts into the United States, 1910–1914, in short tons.

Year.	Production.						Imports.[a]	
	Alum.			Aluminum sulphate.			Quantity.	Value.
	Quantity.	Value.	Per ton.	Quantity.	Value.	Per ton.		
1910	9,090	$300,763	$33.09	126,792	$2,447,552	$19.30	2,127	$53,671
1911	10,468	329,686	31.49	134,077	2,743,336	20.46	2,283	56,833
1912	9,246	293,995	31.80	150,427	2,909,495	19.34	3,342	84,606
1913	9,605	312,822	32.57	157,749	2,977,708	18.88	2,702	66,549
1914	18,238	565,989	31.03	164,954	2,942,572	17.84	2,891	73,028

[a] Includes alumina, aluminum hydrate, or refined bauxite, alum, alum cake, aluminum sulphate, aluminous cake, and alum in crystals or ground.

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GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO IN 1914.[1]

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The value of the production of gold, silver, copper, lead, and zinc from New Mexico ores and gravels for 1914, as reported from 139 productive mines, 24 of which were placers, amounted to $11,049,932. As compared with $11,694,002 in 1913, this shows a decrease in value for 1914 of $644,070. The gold yield was 56,680.79 fine ounces, valued at $1,171,696, an increase in 1914 of 14,017.62 fine ounces in quantity and of $289,770 in value. The yield of silver was 1,777,445 fine ounces, valued at $982,927, an increase of 146,172 fine ounces in quantity, but a decrease of $2,362 in value. The copper output was 59,307,925 pounds, an increase in 1914 of 2,999,219 pounds; the lead output (calculated as lead in lead bullion and lead in zinc-lead oxide) was 1,763,641 pounds, a decrease of 2,182,723 pounds; and the zinc output (calculated as spelter and zinc in zinc-lead oxide) was 18,403,392 pounds, an increase of 1,880,231 pounds. The value of the base metals showed a decrease of $839,896 for copper, a decrease of $104,858 for lead, and an increase of $13,276 for zinc (valued at the average yearly price of spelter for each year).

There were 2,232,853 short tons of ore sold or treated in 1914, as compared with 2,217,660 short tons in 1913.

During 1914 there were treated at amalgamating and cyaniding mills in New Mexico 156,913 tons of ore, and the bullion saved amounted to $614,587 in gold, an average value per ton of $3.92, and 1,161,455 ounces of silver, valued at $642,289, an average recovery per ton of 7.40 ounces, and an average value of $4.09, the value in gold and silver being $1,256,876, an average value per ton of $8.01. The recovery as bullion per ton of ore treated in 1913 was $4.13 in gold and $4.97 in silver, a total of $9.10.

[1] For discussion of the geology of the districts mentioned in the following pages the reader is referred to the bibliography appended to the report for 1912, in Mineral Resources for 1912, pt. 1, p. 819, 1913, and to Survey Bulletin 507, The mining districts of the western United States, by J. M. Hill, with a geological introduction by Waldemar Lindgren, 1912.

Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1904–1914.

Year.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	102,339	$381,930	214,553	4,972,170	3,122,872	13,493,835	$1,961,390
1905	145,629	317,510	369,192	6,126,025	1,510,209	15,142,254	2,460,535
1906	207,691	293,019	491,127	7,028,670	2,987,369	17,292,655	3,203,739
1907	219,992	329,982	705,544	10,990,015	3,809,881	750,085	3,239,823
1908	135,434	298,757	405,044	6,112,630	873,763	3,576,516	1,525,091
1909	164,156	239,491	397,783	5,393,146	5,029,767	13,085,945	2,070,368
1910	191,865	482,424	843,987	4,614,386	4,320,841	18,088,129	2,691,080
1911	232,699	762,808	1,354,540	4,057,040	2,966,222	10,237,176	2,704,843
1912	1,352,286	784,446	1,536,701	34,030,964	5,494,018	13,566,637	8,527,955
1913	2,217,660	881,926	1,631,273	56,308,706	3,946,364	16,523,161	11,694,002
1914	2,232,853	1,171,696	1,777,445	59,307,925	1,763,641	18,403,392	11,049,932
Increase (+) or decrease (−)	+15,193	+289,770	+146,172	+2,999,219	−2,182,723	+1,880,231	−644,070

[a] Includes placer production.

GOLD.

The recoverable gold production from New Mexico ores and gravels in 1914 amounted to 56,680.79 fine ounces, valued at $1,171,696, as against 42,663.17 fine ounces, valued at $881,926, in 1913, an increase of 14,017.62 fine ounces in quantity and of $289,770 in value. Socorro County alone produced 30,542.38 fine ounces, valued at $631,367, or nearly 54 per cent of the total State yield. This was almost entirely from the siliceous ore mines at Mogollon. There were increased yields of gold in Colfax, Dona Ana, Grant, Lincoln, Sandoval, Sierra, and Socorro counties. Dry and siliceous ores furnished in the whole State 43,630.49 fine ounces, valued at $901,922, or 77 per cent of the total. Copper ores contained 11,352.45 fine ounces, valued at $234,676, or 20 per cent of the total, chiefly from Central, Lordsburg, and Pinos Altos districts, Grant County. Lead ores furnished 268.86 fine ounces, valued at $5,558, or 0.47 per cent of the total, chiefly from Grant County, and from Magdalena, Socorro County. Copper-lead ores furnished a negligible percentage of the total gold. The production of placer gold amounted to 1,410.22 fine ounces, valued at $29,152, or 2 per cent of the total.

Source of gold production in New Mexico, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placer mines.	Deep mines.				Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Copper-lead ores.	Lead-zinc ores.	
Colfax	238.49						238.49
Dona Ana			43.11	0.23	1.50		44.84
Grant	1,042.96	4,609.23	10,673.44	158.01	5.46		16,489.10
Lincoln	43.92						43.92
Colfax, Lincoln, Sandoval		6,859.24	2.82		.62		6,862.68
Luna				10.93			10.93
Otero		1,516.34	346.82				1,863.16
Santa Fe	63.47	187.24	250.07				500.78
Sierra	21.38	20.12	36.19	6.28	.54		84.51
Socorro		30,438.32		93.41	10.65		30,542.38
Total, 1914	1,410.22	43,630.49	11,352.45	268.86	18.77		56,680.79
Total, 1913	380.27	36,839.28	4,697.38	707.91	12.90	25.43	42,663.17
Increase (+) or decrease (−)	+1,029.95	+6,791.21	+6,655.07	−439.05	+5.87	−25.43	+14,017.62

SILVER.

The recoverable silver yield from New Mexico ores in 1914 amounted to 1,777,445 fine ounces, valued at $982,927, as compared with 1,631,273 fine ounces, valued at $985,289, in 1913, an increase for 1914 of 146,172 fine ounces in quantity but a decrease of $2,362 in value. Of the total Socorro County produced 1,424,763 fine ounces, or 80 per cent, chiefly from siliceous ore from the Mogollon district, the remainder from mixed ores of the Magdalena district. Grant County furnished 304,679 ounces, or 17 per cent of the total, chiefly from the Lordsburg district. The yield of silver from Grant and Socorro counties combined was 97 per cent of the total.

Dry and siliceous gold and silver ore, chiefly from Socorro and Grant counties, furnished 1,459,814 fine ounces of silver, or 82 per cent of the total; copper ores, chiefly from Grant, Socorro, and Santa Fe counties, furnished 292,266 ounces, or 16 per cent; lead ores, chiefly from Grant County, furnished 17,875 ounces, or 1 per cent; and copper-lead ores, chiefly from Socorro County, furnished 7,160 ounces, or less than 1 per cent.

Source of silver production in New Mexico, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placer mines.	Deep mines.					Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Copper-lead ores.	Lead-zinc ores.	
Colfax	29						29
Dona Ana			2,625	105	834		3,564
Grant	294	19,514	272,774	11,454	643		304,679
Lincoln	3						3
Colfax, Lincoln, Sandoval		25,317	599		50		25,966
Luna			9	2,966			2,975
Otero		4,455	1,306				5,761
Santa Fe	4	62	5,488	169			5,723
Sierra		137	2,095	1,324	426		3,982
Socorro		1,410,329	7,370	1,857	5,207		1,424,763
Total, 1914	330	1,459,814	292,266	17,875	7,160		1,777,445
Total, 1913	90	1,348,514	197,574	68,923	4,652	11,520	1,611,273
Increase (+) or decrease (−)	+240	+111,300	+94,692	−51,048	+2,508	−11,520	+146,172

COPPER.

In 1914 the production of copper in New Mexico amounted to 59,307,925 pounds, valued at $7,887,954, an increase of 2,999,219 pounds, but a decrease in value of $839,896, as compared with the output of 1913. Grant County, chiefly from the output of the Chino Copper Co., at Santa Rita, and from Lordsburg and Pinos Altos, produced 58,259,113 pounds, or 98 per cent of the total. The increase for the year in Grant County was 4,822,936 pounds. The yield from Colfax County increased 9,936 pounds; from Dona Ana County, 67,791 pounds; from Lincoln County, 8,000 pounds; from Luna County, 728 pounds; and from Sierra County, 11,868 pounds. There were decreases in Otero, Santa Fe, and Socorro counties.

Copper ores, chiefly from Dona Ana, Grant, Otero, Santa Fe, and Socorro counties, furnished 58,878,988 pounds, or 99 per cent of the total; dry and siliceous gold and silver ore (chiefly from the dry ore

of Otero County) and from the siliceous ore of Lordsburg district, Grant County, furnished 366,288 pounds, or less than 1 per cent; lead ores, chiefly from the Central district, Grant County, yielded 20,658 pounds; and copper-lead ores, chiefly from Dona Ana, Grant, and Socorro counties, 41,991 pounds.

There were 5,909,314 pounds of copper contained in crude ore shipped to smelters, representing 10 per cent of the total, and concentrates contained 53,398,611 pounds, or 90 per cent.

Source of copper production in New Mexico, by kinds of ore, in 1914, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Colfax	1,433	9,650	.....	.....	.....	11,083
Dona Ana	.....	66,661	.....	11,519	.....	78,180
Eddy	.....	1,466	.....	.....	.....	1,466
Grant	122,186	58,104,000	19,636	13,291	.....	58,259,113
Lincoln	.....	14,422	.....	646	.....	15,068
Luna	.....	1,296	885	.....	.....	2,181
Otero	242,079	176,237	.....	.....	.....	418,316
Santa Fe	408	292,952	.....	.....	.....	293,360
Sierra	182	11,171	.....	3,083	.....	14,436
Socorro	.....	201,133	137	13,452	.....	214,722
Total, 1914	366,288	58,878,988	20,658	41,991	.....	59,307,925
Total, 1913	925,593	55,334,759	26,680	7,898	13,776	56,308,706
Increase (+) or decrease (−)	−559,305	+3,544,229	−6,022	+34,093	−13,776	+2,999,219

LEAD.

Lead production decreased from 3,946,364 pounds in 1913 to 1,763,641 pounds in 1914. The output in 1914 was valued at $68,782.

The chief lead-producing districts were the Magdalena district, Socorro County; the Central district, Grant County; and the Cooks district, Luna County. Socorro County yielded 674,795 pounds, Grant County, 570,513 pounds, and Luna County, 416,923 pounds. Concentrates contained 637 pounds, and crude ore to smelters contained 1,763,004 pounds.

Lead ores furnished 1,198,012 pounds and zinc and lead-zinc ores 444,785 pounds, the combined content representing 93 per cent of the total.

Source of lead production in New Mexico, by kinds of ore, in 1914, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Colfax	154	.....	.....	.....	.....	.....	154
Dona Ana	.....	3,674	1,088	.....	25,135	.....	29,897
Grant	12,445	1,106	517,607	.....	39,355	.....	570,513
Lincoln	.....	6,329	.....	.....	4,312	.....	10,641
Luna	.....	.....	411,515	5,408	.....	.....	416,923
Otero	2,027	.....	.....	.....	.....	.....	2,027
Santa Fe	.....	494	2,549	.....	.....	49,905	52,948
Sierra	590	.....	974	.....	4,769	.....	5,743
Socorro	.....	.....	264,279	91,296	20,454	298,176	674,795
Total, 1914	15,216	11,603	1,198,012	96,704	94,025	348,081	1,763,641
Total, 1913	87,896	26,224	2,623,902	.....	21,634	1,186,708	3,946,364
Increase (+) or decrease (−)	−72,680	−14,621	−1,425,890	+96,704	+72,391	−838,627	−2,182,723

ZINC.

The total recoverable zinc, whether marketed as spelter or oxide, from crude ore and concentrates shipped from New Mexico in 1914, and calculated in terms of spelter and zinc in zinc oxide, was 18,403,392 pounds, valued (in terms of average price of spelter for the year) at $938,573. In terms of marketable metal, the value of the zinc contained in ore from New Mexico in 1914 was $44,354 less than the silver output, and $233,123 less than the gold yield.

Mines producing zinc in New Mexico in 1914 were at Kelly, Socorro County; in Cooks district, Luna County; in Central and Pinos Altos districts, Grant County; and in Santa Fe County.

The ore from Central and Pinos Altos districts, Grant County, from Luna County, and from Santa Fe County is shipped crude; that from Socorro County is in part shipped crude and in part shipped as concentrates.

Zinc ore and concentrates as marketed, in New Mexico, in 1913 and 1914, in short tons, and average assay of zinc.

Year.	Character.	Quantity.	Average assay.
		Short tons.	*Per cent.*
1913	Carbonate and sulphide (ore and concentrates)	25,726	37.81
1914	do	29,459	37.53
Increase (+) or decrease (−).		+3,733	−0.28

SMELTERS.

The bulk of the smelting lead and copper ores and concentrates continued to be shipped to the El Paso (Tex.) smelter.[1] Some ore and concentrates were shipped to Pueblo, Colo. Shipments were also made to the Copper Queen smelter at Douglas, Ariz., to the Calumet and Arizona smelter at Douglas, Ariz., to the Shannon smelter at Clifton, Ariz., and to the Hayden smelter at Hayden, Ariz. Bullion and ore were shipped to Selby, Cal. Zinc ore and concentrates were shipped to smelters and zinc oxide plants in Kansas, Oklahoma, Wisconsin, and at eastern points.

MINING INDUSTRY IN NEW MEXICO IN 1914.

In 1914 the production from New Mexico mines showed an increase in quantity of gold, silver, copper, and zinc, but a decrease for lead. The mine output of gold was $1,171,696, an increase of $289,770; of silver, 1,777,445 ounces, an increase of 146,172 ounces; of copper, 59,307,925, an increase of 2,999,219 pounds; of lead (calculated as lead in lead bullion and lead in leaded-zinc oxide), 1,763,641 pounds, a decrease of 2,182,723 pounds; and zinc (calculated as spelter and zinc in leaded-zinc oxide), 18,403,392 pounds, an increase of 1,880,231 pounds. Because of lower average prices for silver, copper, lead, and zinc, the total value of the output was $11,049,932, a decrease of $644,070, as compared with 1913.

[1] Easter, H. F., Lead smelting at El Paso: Am. Inst. Min. Eng. Bull. 104, pp. 1493–1506, 1915.

The Mogollon district, Socorro County, 80 miles from the nearest railroad at Silver City (Grant County) continued the most important district in New Mexico in the output of gold and silver. The production in 1914 of $629,102 in gold and 1,410,327 ounces of silver was an increase of $9,216 for gold and of 103,561 ounces in quantity, but a decrease of $9,377 in value for silver. The gold output of this district in 1914 represented 54 per cent of the State yield of this metal, and the silver yield was 79 per cent of the total silver output. All the ore was milled in the district by concentration, sliming, and agitation and percolation in cyanide solution, the bulk of the product being cyanide precipitates, with several cars of high-grade gold-silver concentrates. In terms of recovered metal, the ore averaged per ton 0.2236 ounce, or $4.62 in gold, and 10.36 ounces, or $5.73 in silver. A small quantity of lead was recovered from concentrates. In one or two veins in this district are found important quantities of the copper minerals, bornite and chalcocite, but no ore was produced from these veins in 1914. Pinos Altos district, Grant County, became the second in importance of gold output with a yield of $135,741 in gold from both placer and deep mines, the yield increasing heavily from both sources. Some exceptionally high-grade gold ore was shipped from this district in several lots of a ton or less each. This district also produces silver, copper, lead, and zinc. There was an increased output of gold bullion from the amalgamation mill at the North and South Homestake mines, at White-oaks, Lincoln County. This district has yielded a large quantity of gold. The Elizabethtown district, Colfax County, in point of total production to date one of the leading mining districts in New Mexico, both from placers and lode mines, made a heavily increased output of gold in the form of bullion, smelting ore, and concentrates from the Aztec mine. With only a small increased placer yield, this district in 1914 gave way to Pinos Altos as the principal placer-producing district. The Lordsburg district, Grant County, with heavily increased shipments of siliceous gold-and-silver-bearing copper and dry ores from fissure veins, doubled its gold output and increased its silver yield over 50 per cent. During 1914 the presence of gold in the concentrates of the Chino Copper Co. was found in quantities sufficiently large to be credited under its smelting contract with 2.71 cents per ton of original crude ore treated or 0.1 cent per pound of copper produced, and represented a very appreciable quantity of gold in the total. A decrease of over one-half in the tonnage of gold-copper ores from the Jarilla district, near Orogrande, Otero County, did not, however, decrease the yield of gold in the same proportion, as the average content in gold was higher in 1914. The operation of the mines and the matte smelter of the Santa Fe Gold & Copper Co., at San Pedro, Santa Fe County (reopened in July, 1912, after being idle since 1907), for only one month in 1914, as compared with 10½ months in 1913, caused a decreased yield of gold from this district. The various districts of Sierra County made only a small production. The Cochiti (Bland) district, Sandoval County, inactive since 1904, but with a record from 1894 to 1904 of $695,000 in gold and $345,000 in silver, was reopened in December, 1913, and in September, 1914, a 100-ton cyanidation plant was placed in operation and operated the rest of the year on one-half capacity, with an appreciable output of gold-silver cyanide precipitates.

Copper has been an important metal in the production of New Mexico, the recorded output from 1845 to 1910 having been 92,323,163 pounds [1] and the total to the end of 1914 being 246,027,798 pounds. Since 1910 the increased production is due principally to the output of the Chino Copper Co., mining with steam shovels a large acreage of low-grade copper deposits at Santa Rita and milling at Hurley, in a wet-concentration plant of five sections, where an average of 5,225 tons a day was treated during 1914, or 6,300 tons a day calculated on the actual running time. The company reports that the ore developed during the year is equal to the amount treated during the year and that the ore reserves are still 90,000,000 tons of 1.75 per cent copper. The output in 1914 was 56,841,977 pounds. During the first seven months the operation of the plant was practically at full capacity and, it is interesting to note, was producing at the rate of over 70,000,000 pounds of copper per annum. During the last five months the production was reduced to practically a 50 per cent basis, owing to conditions resulting from the European war. The copper output of Lordsburg, Grant County, increased 63 per cent but did not equal the record yield of 1912. The mines and 125-ton matting plant at San Pedro, Sante Fe County, were operated only one month as compared with 10½ months in 1913. The output of copper from the Jarilla district decreased 50 per cent. In the Burro Mountain district, the Burro Mountain Copper Co. operated its 50-ton experimental mill, and results were such as to justify the resumption of the construction of a mill with a capacity of 1,000 tons a day.

The yield of lead decreased appreciably. The yield from the lead and lead-zinc ores of Magdalena decreased heavily, as did the yield from Luna County.

The yield of zinc carbonate ore and zinc sulphide ores and concentrates shipped from the State in 1914 was 29,459 tons, averaging 37.53 per cent zinc, as compared with 25,726 tons of 37.81 per cent in 1913. The principal zinc-producing districts in New Mexico are Hanover, Grant County, Cooks Peak, Luna County, and Kelly, Socorro County; and zinc ore has also been shipped from Pinos Altos and Gillespie districts, Grant County, from Tres Hermanas, and Victorio districts, Luna County, and from Cerillos district, Santa Fe County. At Kelly the Ozark Co.'s wet-concentration mill was the only mill in New Mexico producing zinc concentrates in 1914; but the Empire Zinc Co.'s mill at Kelly was undergoing remodeling, and preparations were made for the erection of a mill at Pinos Altos.

[1] Butler, B. S., U. S. Geol. Survey Mineral Resources, 1910, pt. 1, p. 204, 1911.

The following tables show the results of mining operations in New Mexico in 1914:

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1914, by counties.

County.	Number of mines producing.	Ore.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Colfax, Lincoln, Sandoval	18	20,773	7,145.09	$147,702	25,998	$14,378
Dona Ana	3	451	44.84	927	3,564	1,971
Eddy	1	4				
Grant	63	1,986,921	16,489.10	340,860	304,679	168,487
Luna	8	2,127	10.93	226	2,975	1,645
Otero	13	11,176	1,863.16	38,515	5,761	3,186
Santa Fe	8	23,584	500.78	10,352	5,723	3,165
Sierra	8	98	84.51	1,747	3,982	2,202
Socorro	17	187,719	30,542.38	631,367	1,424,763	787,893
Total, 1914	139	2,232,853	56,680.79	1,171,696	1,777,445	982,927
Total, 1913	128	2,217,660	42,663.17	881,926	1,631,273	985,289
Increase (+)	+11	+15,193	+14,017.62	+289,770	+146,172	−2,362

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Colfax, Lincoln, Sandoval	26,151	$3,478	10,795	$421			$165,979
Dona Ana	78,180	10,398	29,897	1,166			14,462
Eddy	1,466	195					195
Grant	58,259,113	7,748,462	570,513	22,250	(b)	(b)	8,280,059
Luna	2,181	290	416,923	16,260	(b)	(b)	18,421
Otero	418,316	55,636	2,027	79			97,416
Santa Fe	293,360	39,017	52,948	2,065	89,860	$4,583	59,182
Sierra	14,436	1,920	5,743	224			6,093
Socorro	214,722	28,558	674,795	26,317	13,785,176	703,044	2,177,179
Grant and Luna					4,528,356	230,946	230,946
Total, 1914	59,307,925	7,887,954	1,763,641	68,782	18,403,392	938,573	11,049,932
Total, 1913	56,308,706	8,727,850	3,946,364	173,640	16,523,161	925,297	11,694,002
Increase (+) or decrease (−)	+2,999,219	−839,896	−2,182,723	−104,858	+1,880,231	+13,276	−644,070

[a] Includes placer production.
[b] In order to avoid disclosing individual production, the production of zinc in Grant and Luna counties is combined.

Ore to gold and silver mills and concentrating mills, with quantity of gold and silver in bullion produced in New Mexico from 1909 to 1914, inclusive.

Year.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
1909	32,830	6,725.84	169,650	78,782
1910	67,148	14,220.94	412,272	61,379
1911	109,113	21,894.14	771,014	59,622
1912	106,208	20,342.58	842,018	1,142,002
1913	124,536	24,891.37	1,024,363	1,987,896
1914	156,913	29,730.64	1,161,455	1,955,881
Increase (+) or decrease (−)	+32,377	+4,839.27	+137,092	−32,015

Mine production of gold, silver, copper, lead, and zinc from New Mexico concentrates from 1909 to 1914, inclusive.

Year.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	7,554	1,598.31	112,639	2,015,118	436,558	821,766
1910	18,298	4,536.03	255,060	1,050,238	2,701,843	6,882,175
1911	16,243	7,938.70	333,654	1,125,927	1,562,768	5,304,000
1912	81,811	7,190.63	290,081	28,760,908	1,984,435	6,404,768
1913	198,243	7,913.39	294,948	51,723,923	1,076,848	8,594,183
1914	161,003	12,754.17	312,734	53,398,611	637	8,541,261
Increase (+) or decrease (−)	−37,240	+4,840.78	+17,786	+1,674,688	−1,076,211	−52,922

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore shipped to smelters from 1909 to 1914, inclusive.

Year.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	52,544	2,196.50	115,332	3,378,028	4,593,209	12,264,179
1910	63,338	3,317.99	176,281	3,564,148	1,618,998	11,205,954
1911	63,964	6,162.71	249,710	2,931,113	1,403,454	4,933,176
1912	104,076	9,595.57	404,462	5,270,056	3,509,583	7,161,869
1913	105,228	9,478.13	311,872	4,584,783	2,869,516	7,928,978
1914	120,059	12,785.76	302,926	5,909,314	1,763,004	9,862,131
Increase (+) or decrease (−)	+14,831	+3,307.63	−8,946	+1,324,531	−1,106,512	+1,933,153
Subdivision by kinds of ore:						
Dry and siliceous	11,565	5,971.45	23,178	358,498	14,579	.....
Copper	87,920	6,526.68	254,713	5,488,168	11,603	.....
Lead	2,491	268.86	17,875	20,658	1,198,012	.....
Copper-lead	380	18.77	7,160	41,990	94,025	.....
Zinc and lead-zinc	17,703	.....	.....	.....	444,785	9,862,131

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore and concentrates combined shipped to smelters from 1909 to 1914, inclusive.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	60,098	3,794.81	227,971	5,393,146	5,029,767	13,085,945
1910	81,636	7,854.02	431,341	4,614,386	4,320,841	18,088,129
1911	80,207	14,101.41	583,364	4,057,040	2,966,222	10,237,176
1912	185,887	16,786.20	694,543	34,030,964	5,494,018	13,566,637
1913	303,471	17,391.52	606,820	56,308,706	3,946,364	16,[illegible]23,161
1914	181,062	25,539.93	615,660	59,307,925	1,763,641	18,403,392
Increase (+) or decrease (−)	−122,409	+8,148.41	+8,840	+2,999,219	−2,182,723	+1,880,231

Ore to gold and silver mills, and concentrating mills, with quantity of gold and silver bullion produced in New Mexico in 1914, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Colfax, Lincoln, and Sandoval	20,619	6,237.61	25,142	.....
Grant	.....	381.86	478	1,917,672
Santa Fe	170	105.58	34	.....
Socorro	136,124	23,005.59	1,135,801	38,209
Total	156,913	29,730.64	1,161,455	1,955,881

Mine production of gold, silver, copper, lead, and zinc from New Mexico concentrates in 1913 and 1914.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	68	381.67	97	1,045	47	.....
Grant	48,919	4,939.77	38,109	53,397,566	.....	.....
Socorro	12,016	7,432.73	274,528	.....	590	8,541,261
Total	61,003	12,754.17	312,734	53,398,611	637	8,541,261

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore shipped to smelters in 1914, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	72	239.96	78	10,038	107	.....
Dona Ana	451	44.84	3,564	78,180	29,897	.....
Eddy	4	.....	.....	1,466	.....	.....
Grant	69,249	10,124.51	265,798	4,861,547	570,513	.....
Lincoln	82	3.44	649	15,068	10,641	.....
Grant, Luna, and Socorro	.....	.....	.....	.....	.....	[a] 9,772,271
Luna	2,127	10.93	2,975	2,181	416,923	.....
Otero	11,176	1,863.16	5,761	418,316	2,027	.....
Santa Fe	23,414	331.73	5,685	293,360	52,948	89,860
Sierra	98	63.13	3,982	14,436	5,743	.....
Socorro	13,386	104.06	14,434	214,722	674,205	.....
Total	120,059	12,785.76	302,926	5,909,314	1,763,004	9,862,131

[a] In order to avoid disclosing individual production, zinc production from Grant, Luna, and Socorro counties are combined.

Ore sent to gold and silver mills, with quantity of gold and silver contained in bullion produced in New Mexico in 1914, by processes.

Process.	Quantity.	Gold in bullion.	Silver in bullion.
	Short tons.	*Fine ounces.*	*Fine ounces.*
Amalgamation	16,416	5,945.14	1,199
Cyanidation	140,497	23,785.50	1,160,256
	156,913	29,730.64	1,161,455

Consumption of quicksilver and cyanide in New Mexico in 1914.

Quicksilver.	Potassium cyanide.	Sodium cyanide.
Pounds.	*Pounds.*	*Pounds.*
[a] 365	.....	[b] 237,511

[a] Represents 1 pound of quicksilver for every 16.29 ounces of gold.
[b] Represents 1 pound of cyanide for every 0.10 ounce of gold, and 1 pound of cyanide for every 4.89 ounces of silver.

Subdivision of ore sold or treated in New Mexico in 1914, by counties, in short tons.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc and lead-zinc ores.	Copper-lead ores.	Total.
Colfax, Lincoln, Sandoval	20,661	103	.....	.....	9	20,773
Dona Ana	.....	371	4	.....	76	451
Eddy	.....	4	.....	.....	.....	4
Grant	3,602	1,976,013	1,186	.....	141	1,980,942
Luna	.....	7	604	.....	.....	611
Otero	8,454	2,722	.....	.....	.....	11,176
Santa Fe	194	23,151	23	216	.....	23,584
Sierra	11	53	8	.....	26	98
Socorro	136,124	2,600	666	48,200	128	139,518
Grant and Luna	.....	.....	.....	7,496	.....	55,696
Total, 1914	169,046	2,005,024	2,491	55,912	380	2,232,853
Total, 1913	154,607	2,006,014	7,762	49,174	103	2,217,660
Increase (+) or decrease (−)	+14,439	−990	−5,271	+6,738	+277	+15,193

Output of ore and placers, and production of metals in New Mexico, by kinds of ore, in 1914.

Source of production.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	.....	1,410.22	330	.....	.....	.....
Dry and siliceous gold and silver ores	169,046	43,630.49	1,459,814	366,288	15,216	.....
Copper ores	2,005,024	11,352.45	292,266	58,878,988	11,603	.....
Lead ores	2,491	268.86	17,875	20,658	1,198,012	.....
Zinc and lead-zinc ores	55,912	.....	.....	.....	444,785	18,403,392
Copper-lead ores	380	18.77	7,160	41,991	94,025	.....
Total	2,232,853	56,680.79	1,777,445	59,307,925	1,763,641	18,403,392

REDUCTION MILLS IN NEW MEXICO IN 1914.

Mineral Resources for 1912, part 1, pages 832–835, contained a complete list of the reduction mills in New Mexico in 1912, with description of equipment and process. Any changes in this list for 1914 have been noted in the text of the various counties, and reference should be made to the 1912 report for detailed equipment.

REVIEW BY COUNTIES.[1]

BERNALILLO COUNTY.[2]

No ore was marketed from Bernalillo County in 1914. Assessment work and development work was done on several prospects in the Coyote, Hell Canyon, and Soda Springs districts.

COLFAX COUNTY.[3]

Elizabethtown district (including Baldy).—Placer mines in this district yielded $4,930 in gold in 1914, as compared with $4,550 in 1913.

[1] Discussions of the geology of the several districts are given in the publications cited in many of the footnotes in this section.

[2] Lindgren, Waldemar, The ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, pp. 162–163, 1910.

[3] Idem, pp. 18, 32, 36, 41, 51–54, 57–59, 60, 75, 91–108, 348.

With a heavy increase in placer production Pinos Altos district, Grant County, surpassed the yield of Elizabethtown district, long the principal producing placer district in New Mexico.

Producing lode mines were the Aztec, Mystic, and Winburn. Only small shipments were made from the Mystic and Winburn, but a heavily increased yield was made from the Aztec mine and 10-stamp amalgamation-concentration mill. The small shipments of crude ore and concentrates from this property carried a high content of gold. Development work was continued at the Golden Ajax mine.

The following table shows the production of Elizabethtown and Baldy districts (which is the output for Colfax County) from 1904 to 1914, inclusive. Owing to the fact that the lode production is almost entirely from one mine, the deep mine production for 1914 has been combined with Lincoln and Sandoval counties.

Mine production in Elizabethtown district, Colfax County, N. Mex., 1904–1914.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	380	$90,639	$3,638	67	.....	.....	$94,316
1905	13	31,994	445	157	.....	.....	31,749
1906	.....	14,492	.....	93	.....	.....	14,554
1907	.....	11,914	.....	83	.....	.....	11,969
1908	.....	11,274	.....	66	.....	.....	11,309
1909	83	16,037	1,705	127	.....	.....	17,808
1910	93	9,588	3,433	261	.....	2,182	13,258
1911	2,306	9,860	31,547	1,254	5,587	.....	42,770
1912	3,025	8,385	27,316	634	6,243	.....	37,121
1913	3,222	4,550	15,588	254	1,147	134	20,475
1914	2,860	4,930	(a)	577	11,083	154	(a)
Increase (+) or decrease (−)	−362	+389	.....	+323	+9,936	+20	(a)

a To avoid disclosing individual production, the output of gold from Colfax County is combined with that of Lincoln and Sandoval counties.

DONA ANA COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Dona Ana County, N. Mex., 1904–1914.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	5,580	.....	24,101	40,000	1,581,488	.....	$87,145
1905	6,566	$6,710	21,776	96,058	327,707	30,000	52,020
1906	16,220	.....	34,051	434,000	1,207,193	.....	175,386
1907	6,084	6	25,612	776,125	675,189	.....	207,920
1908	3,090	.....	9,283	21,150	379,697	.....	23,660
1909	2,816	248	16,975	10,600	772,023	.....	43,650
1910	2	.....	15	.....	705	.....	39
1911	5	.....	111	353	1,561	.....	173
1912	78	17	1,790	6,685	26,129	.....	3,397
1913	155	30	1,232	10,189	9,557	.....	2,774
1914	451	927	3,564	78,180	29,897	.....	14,462
Increase (+) or decrease (−)	+296	+897	+2,332	+67,991	+20,340	.....	+11,688

Organ Mountains district.[1]—Several shipments of lead and copper ores were made from the Excelsior, Memphis, and Stephenson-Bennett mines.

Franklin Mountains.—A small shipment of lead ore was made from a prospect in the northern end of the Franklin Mountains, in Dona Ana County.

EDDY COUNTY.

A small shipment of copper ore was made from a surface deposit near Artesia.

GRANT COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Grant County, N. Mex., 1904–1914.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	47,032	$8,081	$60,347	74,793	4,428,508	179,142	.....	$695,099
1905	81,160	10,943	35,064	86,629	5,291,222	321,035	257,203	954,026
1906	127,800	2,290	97,519	163,987	6,388,830	710,895	144,656	1,492,069
1907	146,746	3,782	109,260	224,279	8,046,315	1,394,390	73,729	1,948,582
1908	75,254	3,514	42,168	95,477	5,242,767	244,589	251,070	810,403
1909	89,576	3,584	34,242	74,198	5,176,585	215,070	203,278	769,590
1910	70,862	2,641	63,291	156,557	4,404,394	257,953	1,285,500	790,598
1911	93,770	4,043	112,241	221,882	3,918,928	694,247	306,895	772,481
1912	1,200,691	2,551	163,645	356,057	32,952,133	2,309,732	3,135,000	6,142,526
1913	1,984,304	1,646	102,971	206,215	53,436,177	446,805	2,553,322	8,674,423
1914	1,986,921	21,560	319,300	304,679	58,259,113	570,513	(*a*)	(*a*)
Increase (+)	+2,617	+19,914	+216,329	+98,464	+4,822,936	+123,708	(*a*)	(*a*)

a To avoid disclosing individual production, the zinc production of Grant County is combined with Luna County.

Apache No. 2 (Anderson) district.[2]—Development work was done, but no shipments were made in 1914.

Burro Mountain district.[3]—The Burro Mountain Copper Co. operated its 50-ton experimental mill from March through the year. The mill is equipped with Wilfley tables, vanners, and flotation processes. The yield was copper concentrates and copper precipitates.

The annual report [4] of Phelps, Dodge & Co. for 1914 (dated February 1, 1915), says of the Burro Mountain Copper Co.:

As a preliminary to the active construction of the new mill a systematic series of experiments on mechanical concentration and flotation were made to determine the methods and machinery best suited to the Burro ores. While engaged in making these tests the erection of the mill was suspended, but the experiments have proved

[1] Lindgren, Waldemar, op. cit., pp. 205–213.

[2] As distinguished from Apache (Chloride) district, Sierra County. See Hill, J. M., Mining districts of western United States: U. S. Geol. Survey Bull. 507, pp. 231, 240, 1912.
Lindgren, Waldemar, op. cit., pp. 343–344.
Weed, W. H., The Copper Mines of the United States in 1905: U. S. Geol. Survey Bull. 285, p. 118, 1906.

[3] Lindgren, Waldemar, op. cit., pp. 17, 19, 27, 28, 38, 61, 62, 321–324.
Paige, Sidney, Metalliferous ore deposits near the Burro Mountains, Grant County, N. Mex.: U. S. Geol. Survey Bull. 470, pp. 131–150, 1911.
Weed, W. H., op. cit., p. 118.
See Somers, R. E., Geology of the Burro Mountains: Am. Inst. Min. Eng. Bull. 101, pp. 957–996, May, 1915. Also Bush, F. V., Burro Mountain porphyry copper developments: Min. and Sci. Press, Feb. 6, 1915, pp. 222–224.

[4] See Min. and Sci. Press, May 22, 1915, pp. 803, 818–819.

sufficiently encouraging to justify the resumption of the construction of a mill with a capacity of 1,000 tons a day. The tables of results of the experimental mill show a gradual improvement in extraction from 53.90 in May to 79.80 in December, largely through modifications in the mechanical appliances and practice.

During the year the first of the large 1,000-horsepower internal-combustion engines of the Diesel type has been erected and started and the estimates of efficiency by the builder have been confirmed. A second 1,000-horsepower engine now being erected will supply the immediate requirements of the company after the mill is started; but a third engine will be needed as a measure of precaution.

The mining operations have consisted in the development of the so-called Bison ore body encountered while driving the main tunnel from Tyrone to the eastern ore body on the Leopold property. In addition to exploring it, the best method of attacking the Tyrone ore bodies has been carefully studied.

The hoists of No. 2 and No. 3 shafts on the Chemung property have been replaced by machinery of greater capacity, and the shafts themselves are being overhauled for active service.

Churn drilling operations have been systematically carried out during the year. Thirteen holes, with an aggregate of 11,571 feet, have been drilled, as might be expected, with variable results. They will prove valuable as guides when looking for new ore. * * * Before the close of the year it is hoped that the mines and mill will be in full operation.

At the Azure Mining Co.'s property a new vertical shaft 300 feet deep was sunk and churn drill prospecting was done.

Central district.[1]—The output of the Central district, embracing the towns of Bayard, Fierro,[2] Georgetown,[3] Hanover,[4] and Santa Rita,[5] was 1,934,020 tons, yielding $102,971 in gold, 42,971 ounces of silver, 55,222,874 pounds of copper, 365,079 pounds of lead, and an increased yield of zinc. This district ranks first in point of present production. Besides the Chino Copper Co.'s mines at Santa Rita there were 16 other producing mines in this district. Zinc carbonate ore was shipped from the Mountain Home group, Welch group, and Empire Zinc Co.'s mines. Oxidized copper ore was shipped from the Copper Queen property, at Fierro. Copper-lead ore was shipped from the Ground Hog mine, near Vanadium. A considerable quantity of lead and copper ores was shipped from other properties and various dumps in the district.

The Chino Copper Co. is mining a low-grade copper deposit at Santa Rita by steam shovels. The ore is concentrated at Hurley, where is located a 6,000-ton plant, in five sections. Concentrates are shipped principally to El Paso.

The fifth annual report of the Chino Copper Co., dated Apirl 16, 1915, covering the year ended December 31, 1914, says:

There were no additions to the area of the mining property during the year. * * * Two holes partially drilled in 1913 were completed during the year, and four shallow holes were drilled to determine the outline of some high-grade ore cutting into the westerly portion of our South ore body, the total feet so drilled amounting to 981 feet. No other drilling was done solely for development purposes.

In the last annual report it was stated that the amount of fully developed ore as reported for the previous year had not been decreased by our operations, although at that time no calculation had been made of the additional ore that was disclosed by the holes drilled during the year 1913. During 1914 it was necessary to make a new study of the sections in order to determine the limits of stripping, and in this connection a

[1] Lindgren, Waldemar, op. cit., pp. 57, 61, 317–318; Weed, W. H., op. cit., p. 118.
[2] Lindgren, Waldemar, op. cit., pp. 47, 55, 296, 306, 312–313.
[3] Lindgren, Waldemar, op. cit., pp. 18, 30, 38, 62, 63–65, 306, 307, 318–319.
[4] Paige, Sidney, The Hanover iron-ore deposits, New Mexico: U. S. Geol. Survey Bull. 380, pp. 199–214, 1909.
[5] Birkinbine, John, Iron ores of the United States: U. S. Geol. Survey Eighteenth Annual Rept., pt. 5, pp. 48–50, 1897.
Lindgren, Waldemar, op. cit., pp. 3, 5, 18, 38, 41–43, 51–53, 55, 57–58, 305, 317.
Paige, Sidney, op. cit., pp. 119–214.
Weed, W. H., op. cit., p. 118.

calculation was made of the additional ore revealed by the drill holes completed, both in that and the previous year.

The total tonnage previously estimated was 93,840,812 tons of 1.77 per cent copper. The increase, due to the additional ore disclosed by the subsequent drilling, was 1,463,840 tons of 1.47 per cent copper, giving a grand total of 95,304,652 tons of 1.766 per cent copper. Since the starting of the mill in 1911 and up to January 1, 1915, there has been treated a total of 5,012,800 dry tons of ore. An additional 21,697 tons of ore were shipped direct to the smelter, making a total of 5,034,497 tons of ore mined and disposed of to January 1, 1915, and containing an average of 2.09 per cent copper. Deducting this from the calculated ore reserves as stated, leaves 90,270,155 tons of ore, averaging 1.75 per cent copper still available in the fully developed ore bodies.

It should be noted that the additional ore calculated during the last two years is wholly within the known South ore body. There are additional areas surrounding the Sierra and Estrella portions of the Southwest ore body yet to be drilled that will undoubtedly add considerable tonnages of fair-grade ore to the reserves whenever it seems advisable that this development be undertaken.

The primary crushing plant near the mine, upon which construction work was started in the latter part of 1913, was completed and put in operation in August, and began immediately to give results as expected in reduced costs of breaking bowlders and greater efficiency of the shovels, because of their not being delayed while pieces too large to send to the mill were broken by hand before loading, as had formerly been the practice. Another beneficial result was a substantial decrease in the unloading forces at the mill. * * *

Of the ore production for the year shipped to the mill, 20.1 per cent came from the North ore body, 4.2 per cent from the Northwest ore body, 75.6 per cent from the South ore body, and 0.1 per cent from the Southwest ore body. From the South ore body, in addition to the mill shipments, there were produced 19,405 tons of ore which was shipped direct to the smelter. * * * The principal changes in the mill itself were in the installation of an improved concentrate enriching plant.

For the first seven months of this year all five sections of the present plant were available for operation, the average running time of all sections being 95.3 per cent of the possible time. Beginning in August, when curtailment of output was necessary on account of disturbed industrial conditions resulting from the European war, and continuing for the five remaining months of the year, the mill was operated about 66 per cent of the possible time. During the first seven months the mill averaged 1,345 tons per actual section day, while for the last five months it averaged 1,085 tons per actual section day. The ore for the first seven months of the year averaged, however, 2.16 per cent copper as against 1.99 per cent copper for the last five months of the year, which resulted in a reduction in production of practically 50 per cent for the five months' period. During the year there were 1,907,300 dry tons of ore milled, equivalent to an average of 5,225 tons per day for the entire plant, or 1,045 tons per day for each of the five sections. The average rate per section for the entire year calculated on the actual running time was 1,258 tons per day, equivalent to nearly 6,300 tons per day for the entire plant.

The average copper content of the ore treated for the year was 2.1151 per cent. The total production of concentrates was 147,925 tons, corresponding to a ratio of concentration of 12.89 tons of ore to produce 1 ton of concentrates. The total amount of copper contained in concentrates was 54,748,254 pounds, corresponding to an average concentrate grade of 18.505 per cent copper and a recovery of 28.705 pounds of copper per ton of ore, representing an extraction of 67.858 per cent of the copper content. The ratio of concentration is higher than it was for the previous year, this being due in a great measure to the fact that the concentrate cleaning plants were in service throughout the year. * * *

The average cost of net copper produced from concentrates, after making deductions for smelter allowances and crediting gold values, was 7.60 cents per pound as compared with 8.787 cents for the previous year. The gold credit referred to amounted to 2.71 cents per ton of crude ore treated, or 0.1 cent per pound of copper produced. The presence of gold in concentrates in amounts sufficiently large to be credited under our smelting contract was due in part to the higher ratio of concentration, made possible by concentrate recleaning, and in part to the fact that a slight increase in gold contents has been found as greater depths are attained in certain portions of the mine. The average cost for all copper produced for the year, without crediting miscellaneous income, was 7.68 cents per pound. The per pound cost as stated includes operating expenses and charges of every nature except depreciation. If miscellaneous earnings for the year were credited to the cost of producing copper, the net cost of all copper, based as above stated, would be 7.35 cents per pound, as against 8.5 cents on the same basis for the previous year. * * *

The gross production of copper from milling operations amounted to 54,748,254 pounds. In addition, shipments of crude ore direct to the smelter amounted to 2,093,723 pounds, or a total production of copper from both sources of 56,841,977 pounds. The net production, as shown on the income statement, equalled 53,999,928 pounds of refined copper. This production was the result of handling during the year 1,907,300 tons of ore, equivalent to an average of 5,225 tons a day. During the first seven months, the operation of the plant was practically at full capacity. * * * It is interesting to note that your company for the first seven months of the year, operating under normal conditions, was producing at the rate of over 70,000,000 pounds of copper per annum.

Mine production of gold, silver, copper, lead, and zinc in the Central district, Grant County, N. Mex., 1904–1914.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	21,048	$5,582	282	3,264,208	11,977	.....	$430,607
1905	17,115	.....	.....	2,704,233	.....	.....	421,860
1906	39,155	4	2,524	3,075,001	235,070	99,656	614,648
1907	57,079	5,659	36,813	4,994,575	855,358	73,729	1,078,555
1908	41,852	777	296	3,994,502	29,122	251,070	541,231
1909	41,456	816	1,380	3,348,808	23,256	203,278	448,856
1910	37,008	.....	404	2,679,630	155	1,285,500	409,955
1911	45,584	104	8,673	1,413,189	605,978	290,122	325,156
1912	1,136,290	998	29,586	29,512,812	2,172,676	2,205,824	5,138,779
1913	1,948,471	9,697	12,500	51,695,656	331,440	2,187,266	8,167,144
1914	1,934,020	102,971	42,971	55,222,874	365,079	(a)	(a)
Increase (+) or decrease (−)	−14,451	+93,274	+30,471	+3,527,218	+33,639	(a)	(a)

a In order to avoid disclosing individual production, the production of zinc in Central district, Grant County, has been combined with that of Luna County.

Chloride Flat district (near Silver City).[1]—Lead-silver ore was shipped from the Grand Central mine in January, 1914.

Eureka district (Hachita, including Sylvanite).[2]—No production was made from this district in 1914.

Fremont district.—Assessment work was done on the Eagle and Nutshell mines, near the boundary lines of Luna and Grant counties and Mexico.

Gillespie, or Animas Mountains district.—A car of zinc carbonate ore was shipped from the White Rose mine in January, 1914.

Lordsburg district (including Pyramid and Virginia, or Shakespeare districts).[3]—The following table shows the production of Lordsburg district from 1904 to 1914, inclusive:

Mine production of gold, silver, copper, and lead in the Lordsburg district, Grant County, N. Mex., 1904–1914.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	250	$1,184	2,580	18,200	12,000	$5,582
1905	366	10	7,584	48,000	.....	12,079
1906	1,743	5,168	27,261	212,601	.....	64,465
1907	5,645	8,761	31,303	463,335	10,522	122,646
1908	7,532	10,617	9,889	259,079	11,363	50,534
1909	10,690	25,983	50,154	589,969	8,862	129,140
1910	29,220	59,798	130,324	1,627,591	19,662	337,742
1911	46,139	106,648	182,448	2,455,336	2,157	510,359
1912	55,340	144,859	275,251	3,155,585	4,562	835,015
1913	31,284	55,234	154,779	1,601,461	14,572	397,588
1914	38,964	101,080	232,647	2,614,674	30,049	578,658
Increase (+)	+7,680	+45,846	+77,868	+1,013,213	+15,477	+181,070

[1] Lindgren, Waldemar, op. cit., pp. 18, 26, 38, 63–65, 301–305, 1910.
[2] Idem, pp. 335–343.
[3] Graton, L. C., idem, pp. 332–335; Weed, W. H., op. cit., p. 118.

The yield from this district increased heavily in 1914. All the ore is shipped to smelters. The average assay per ton for the district in 1914 was gold, 0.1255 ounce, silver 5.97 ounces, and copper 3.36 per cent. The principal producing mine was the Eighty-Five. Other producing mines were the Battleship, Bonney, Dundee, Green King, Jerry Boyle, Kiedmore, and Robert E. Lee.

Pinos Altos district.[1]—There was a heavy increase in yield of gold from both placer and deep mines in this district in 1914. The following table shows the production of Pinos Altos district from 1904 to 1914, inclusive:

Mine production of gold, silver, copper, lead, and zinc in the Pinos Altos district, Grant County, N. Mex., 1904–1914.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	4,719	$7,750	$49,660	37,229	104,069	2,653	.....	$92,587
1905	6,348	10,943	31,442	39,585	103,469	.....	160,779	82,442
1906	14,074	2,290	89,674	83,566	328,788	.....	.....	211,409
1907	14,841	3,782	78,723	65,862	322,195	.....	.....	190,413
1908	1,451	1,479	8,548	8,941	34,514	3,953	.....	21,528
1909	38	3,584	2,083	1,377	6,200	418	.....	7,207
1910	20	2,494	1,372	223	269	2,226	.....	4,119
1911	355	4,043	1,406	5,616	3,232	4,063	16,773	9,968
1912	6,169	2,551	7,973	15,864	96,507	50,289	929,176	102,581
1913	3,643	1,646	29,162	28,276	100,555	83,067	366,056	87,626
1914	3,686	21,560	114,181	23,256	129,587	29,994	48,840	169,497
Increase (+) or decrease (−)	+43	+19,914	+85,019	−5,020	+29,032	−53,073	−317,216	+81,871

Placer and surface mines in this district yielded $21,560 in gold and 294 ounces of silver in 1914, as compared with only $1,646 in gold and 22 ounces of silver in 1913. Placer gold in this district has a fineness in gold of 0.732 to 0.774 and in silver of 0.211 to 0.226. Some lode specimen gold has a similar fineness. Placer operations are confined to sluicing operations in the gulches.

Deep mines yielded 3,686 tons of ore, carrying $114,181 in gold, 22,962 ounces of silver, 129,587 pounds of copper, 29,994 pounds of lead, and 48,840 pounds of zinc, with a total value of $147,775. From several properties small shipments of less than a ton of ore carried exceedingly high content of gold. There was also considerable metallic gold from this district. Producing mines were the Arizona, Copper Bell, Golden Giant, Langston, Lead Hill, Little Arizona, Manhattan, Mountain Key, Pacific, Silver Cell, and Silver Hill.

The Langston mine is opened by a 215-foot vertical shaft. A 50-ton concentration mill, with crusher, rolls, classifiers, drier, electrostatic separator, was under construction during 1914–15 for treatment of ore from the Langston and Pacific mines. There is a Huntington mill with 2 Wilfley tables on the Golden Giant property. The Peterson concentration mill was operated during the year. There is a mill on the Mountain Key property. Preparations were made in 1914 for a new mill at the Cleveland mine of the Empire Zinc Co.

[1] Lindgren, Waldemar, op. cit., pp. 18, 35, 38, 43, 57–58, 59, 61, 62, 64, 75, 297–301. Paige, Sidney, The ore, deposits near Pinos Altos, N. Mex.: U. S. Geol. Survey Bull. 470, p. 109–125, 1911.

Red Hill district.—Assessment work was done on the Red Hill mine, in this district, in the southwest corner of the county.

San Simon (Granite Gap[1]*) district (Steins).*—Lead ore was shipped from the Granite Gap mine.

Steeple Rock district.[2]—A shipment of gold-silver-copper ore was made from the Twin Peaks mine. Development work was done on the Shamrock claims.

Steins Pass (Kimball[3]*) district.*—Assessment work was done in this district.

White Signal (Cow Springs) district (Whitewater).—Several lots of ore were shipped from this district.

LINCOLN COUNTY.

Mine production of gold, silver, copper, and lead in Lincoln County, N. Mex., 1904–1914.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	820	$20,100	$8,496	2,576	.....	2,261	$30,183
1905	3,060	2,260	5,215	757	14,404	7,511	10,532
1906	6,380	.....	16,463	1,946	.....	.....	17,767
1907	5,767	.....	41,417	721	.....	.....	41,893
1908	4,399	816	28,896	5,472	1,195	.....	32,770
1909	3,633	472	23,391	388	700	7,977	24,499
1910	10,727	1,400	53,876	559	189	5,614	55,849
1911	1,578	1,629	30,305	184	555	6,620	32,399
1912	2,003	1,008	21,408	1,005	9,988	103,911	29,358
1913	5,589	1,027	41,469	1,100	7,068	94,010	48,392
1914	(*a*)	908	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Decrease (−)	.....	−119	.....	.....	.....	.....	.....

a The production of this county is almost entirely from one mine at Whiteoaks, hence the production for 1914 is included with that of Colfax and Sandoval counties.

Gallinas district.[4]—Several cars of copper and copper-lead ores were shipped from this district in 1914.

Jicarilla district.[5]—Several small placer mines in this district produced $908 in gold, as compared with $1,027 in 1913.

Nogal (Bonita, Parsons) district.[6]—Assessment work only was done in this district.

Whiteoaks district.[7]—The only producing mine in this district was the North and South Homestake mines, with a considerably increased output of ore and production of bullion from the 20-stamp amalgamation mill. Some improvements were made on the cyanidation plant, but it was not operated.

[1] Lindgren, Waldemar, op. cit., pp. 51, 53, 62, 63–64, 329–331, 340.
[2] Idem, pp. 68, 69–71, 327–328.
[3] Idem, pp. 68, 69–70, 328–329.
[4] Idem, p. 176.
[5] Idem, pp. 39, 51–53, 57–58, 59, 60, 75, 176, 183–184.
[6] Idem, pp. 39, 57–58, 75, 175–179.
[7] Idem, pp. 19, 39, 57–58, 60, 66, 175–176, 179–182.

LUNA COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Luna County, N. Mex., 1904–1914.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	1,576	$1,695	8,549	16,000	671,772	.....	$37,605
1905	1,346	.....	5,199	.....	463,956	225,000	38,221
1906	1,994	413	11,265	.....	831,193	103,836	61,673
1907	2,048	13,741	8,633	.....	1,022,773	.....	73,646
1908	288	3	1,077	5,934	127,535	.....	6,713
1909	1,163	3,208	6,916	1,115	682,906	.....	36,314
1910	525	26	2,484	47	298,112	.....	14,490
1911	229	104	1,278	1,814	98,888	.....	5,458
1912	3,090	5,687	24,265	.....	827,556	458,594	89,493
1913	5,185	11,085	41,664	1,453	1,158,682	702,028	126,771
1914	2,127	226	2,975	2,181	416,923	(*a*)	(*a*)
Increase (+) or decrease (−)	−3,058	−10,859	−38,689	+728	−741,759	.....	.....

a In order not to disclose individual production, the production of zinc from Luna County in 1914 is included with that of Grant County.

Cooks Peak district.[1]—Increased shipments of lead and zinc carbonate and sulphide ores were made from the Summit group, Desdemona, and Contention mines.

Tres Hermanas district.[2]—No ore was shipped from this district.

Victorio (Gage) district.[3]—Several cars of lead ore were shipped from the Rambler mine.

OTERO COUNTY.

Mine production of gold, silver, copper, and lead in Otero County, N. Mex., 1904–1914.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	170	$1,050	$1,569	164	14,400	.....	$4,586
1905	117	1,036	41	93	53,602	.....	9,495
1906	268	195	228	533	133,166	.....	26,481
1907	12,203	100	14,711	2,135	679,480	.....	152,116
1908	22,418	1,475	34,215	4,351	723,907	.....	133,552
1909	143	100	157	29	6,354	.....	1,098
1910	2,545	6,022	2,559	2,046	49,874	6,046	16,286
1911	1,096	.....	6,718	715	22,730	739	9,971
1912	3,792	2,034	41,005	1,107	146,588	.....	37,907
1913	25,582	42	49,830	7,088	760,914	1,911	172,179
1914	11,176	.....	38,515	5,761	418,316	2,027	97,416
Increase (+) or decrease (−)	−14,406	−42	−11,315	−1,327	−342,598	+116	−74,763

The value of the mine production in 1914 in Otero County, from deep mines only, was $97,416, of which $38,515 was for gold, $3,186 for silver, $55,636 for copper, and $79 for lead.

Highrolls (Sacramento) district.—Several cars of copper ore were shipped from the Courtney and Old Reliable mines.

[1] Lindgren, Waldemar, op. cit., pp. 37, 39, 62, 63, 64, 287–289.

[2] Idem, pp. 38, 41, 51, 55, 57, 58, 287, 292–295. Lindgren, Waldemar, The Tres Hermanas mining district, N. Mex.: U. S. Geol. Survey Bull. 380, pp. 123–128, 1909.

[3] Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 18, 43, 62, 63, 64, 287, 290–292, 1910.

Jarilla (Orogrande, Silver Hill, Brice) district.[1] —Lode mines in the Jarilla district in 1914 produced 11,009 tons of ore, yielding $38,459 in gold, 5,376 ounces of silver, 387,211 pounds of copper, and 2,027 pounds of lead, with a total value of $93,010, as compared with $146,406 in 1913. There was no yield of placer gold in 1914. Producing mines were the By Chance, Delusion, Garnet, and Nannie Baird. All the ore was shipped to smelters.

Tularosa district.[2]—Several cars of copper ore were shipped from the Hembrillo and Sulphur Canyon mines.

RIO ARRIBA COUNTY.

Bromide (Tusas) district.[3]—No work was done in this district.

Hopewell (Headstone) district.[4]—Some development work was done on the King William placers.

SANDOVAL COUNTY.

Cochiti (Bland) district.[5]—This district has been idle since 1904. The Cossak Mining Co. built a 100-ton cyanidation plant, and from September operated it on one-half capacity on ore from the Lone Star mine. The equipment of the mill is as follows: Blake crusher, 20 stamps (1,050 pounds each), two 5 by 8 foot tube mills, Dorr duplex classifier, 7 cyanide tanks, continuous agitation counter current decantation process, 2 Dorr agitators, 5 Dorr thickeners. The mine is opened by a 2,000-foot adit.

SANTA FE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Santa Fe County, N. Mex., 1904–1914.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	170	$4,135	$1,292	.....	2,308	.....	.....	$5,727
1905	180	4,002	2,241	42	.....	.....	.....	2,266
1906	128	6,737	7,143	53	.....	.....	.....	13,916
1907	21,338	1,231	16,748	17,635	1,231,260	.....	.....	275,870
1908	7	1,789	242	6	.....	.....	.....	2,034
1909	2,831	1,817	871	2,295	1,093	213,558	4,426	13,445
1910	4,739	4,262	3,877	3,359	5,150	262,023	74,759	26,173
1911	120	2,359	1,325	2,632	16,644	11,178	.....	7,663
1912	15,335	1,302	10,216	14,178	810,563	12,511	10,565	155,272
1913	29,800	129	26,746	22,076	1,798,769	794	.....	319,053
1914	23,584	1,312	9,040	5,723	293,360	52,948	89,860	59,182
Increase (+) or decrease (—).	−6,216	+1,183	−17,706	−16,353	−1,505,409	+52,154	−89,860	−259,871

The value of the mine production in Santa Fe County, from both deep and placer mines, was $59,182, as compared with $319,053 in 1913. Copper was the most important metal produced.

[1] Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 19, 35, 56, 60, 75, 184–187. Weed, W. H., op. cit., p. 118.
[2] Lindgren, Waldemar, op. cit., pp. 77, 78, 184, 187–190.
[3] Idem, pp. 49, 50, 51, 124, 126, 130–133.
[4] Idem, pp. 27, 28, 49, 50–51, 75, 124–130.
[5] Idem, pp. 68, 69, 70, 71, 141, 150–158.

Cerrillos district.[1]—Several cars of lead-zinc ore, a car of copper ore, and one of lead ore, were shipped from this district in 1914.

New Placers[2] *and San Pedro*[3] *districts.*—A small output from the Candelaria mine was treated by amalgamation and a car of ore was shipped to smelter. A car of copper ore was shipped from the Morrison mine. The 125-ton matting plant of the Santa Fe Gold & Copper Co. was operated only during January, 1914. There was a yield of $1,312 in placer gold from various small placers. The Santa Fe Gold Dredging Co. reports the installation of dredging machinery to operate on the Golden placers between Quartz Mountain and the town of Golden.

SIERRA COUNTY.

Mine production of gold, silver, copper, and lead in Sierra County, N. Mex., 1904–1914.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	1,295	$22,979	$51,617	17,055	16,700	.....	$86,632
1905	3,516	47,878	51,164	8,760	46,664	.....	11,613
1906	3,246	1,509	16,539	8,102	5,995	.....	24,633
1907	700	595	7,629	2,250	5,425	9,548	11,300
1908	680	1,979	16,039	8,589	12,874	6,075	24.524
1909	4,294	.....	10,450	25,698	25,838	49,023	29,280
1910	8,306	584	11,113	15,778	2,448	11,274	21,024
1911	5,036	823	26,962	16,487	5,374	28,088	38,459
1912	252	1,546	2,597	11,236	8,988	21,001	13,481
1913	269	423	434	2,529	2,568	32,685	4,221
1914	98	442	1,305	3,982	14,436	5,743	6,093
Increase (+) or decrease (−)	−171	+19	+871	+1,453	+11,868	−26,942	+1,872

The value of the mine production in 1914 in Sierra County, from both deep and placer mines, was $6,093, as compared with $4,221 in 1913.

Caballos Mountains district.[4]—A small lot of copper ore was shipped from the Victoria Chief mine.

Chloride (Apache, Cuchillo Negro) district.[5]—Small shipments were made of copper-lead ore from the Black Knife group and of copper ore from the Black Range tunnel.

Hermosa district.[6]—No production was made in this district.

Hillsboro (Las Animas) district.[7]—A small shipment of copper ore was made from the Mountain Ring mine, and several small lots of copper ore were shipped from other properties. Placer gold was recovered from the Luxemburg placer by the use of the Quenner trommel mill, and the dry concentrator of the Hilltscher Bros.[8] There was a small output from placers operated by Mexicans. Early

[1] Clark, F. W., and Diller, J. S., Turquoise from New Mexico: U. S. Geol. Survey Bull. 42, p. 39, 1887. Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 35, 36, 39, 57, 58, 60, 163–167, 1910.

[2] Lindgren, Waldemar, op. cit., pp. 17, 75, 76, 163, 164, 170–175.

[3] Idem, pp. 51–53, 55, 57–58, 60, 62, 64, 171–174.

[4] Hess, F. L., Vanadium in the Sierra de los Caballos, New Mexico: U. S. Geol. Survey Bull. 530, pp. 157–160, 1912.

[5] Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 27, 28, 29, 30, 74, 218, 229, 238, 283–285, 1910.

[6] Idem, pp. 18, 55, 62–67, 77, 218, 232, 233, 267–268.

[7] Idem, pp. 18, 30, 31, 37, 39, 43, 62, 64, 65, 68, 69, 70, 75, 214, 218, 227–228, 238, 239, 272–276, 277. Weed, W. H., op. cit., p. 118.

[8] For discussion of dry placers in the United States see Heikes, V. C., and Yale, Charles G., U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 255–262, 1913.

in 1915 the old Andrews mine was reopened with a double compartment shaft, and a new milling plant is in prospect.

Kingston (Black Range) district.[1]—Various small lots of ore were shipped from this district. Assessment work was done on various properties.

Tierra Blanca (Bromide No. 1) district.[2]—Assessment work only was done in this district.

SOCORRO COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Socorro County, N. Mex., 1911–1914.

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*	
1911	25,844.49	$534,253	1,109,945	$588,271
1912	25,427.30	525,629	1,126,439	692,754
1913	30,179.04	623,856	1,347,160	813,685
1914	30,542.38	631,367	1,424,763	787,893
Increase (+) or decrease (−)	+363.34	+7,511	+77,603	−25,792

Year.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
1911	79,321	$9,915	2,124,901	$95,621	9,930,281	$566,026	$1,794,086
1912	89,776	14,813	2,193,178	98,693	9,962,478	687,411	2,019,300
1913	289,566	44,883	2,199,247	96,767	13,267,811	742,997	2,322,188
1914	214,722	28,588	674,795	26,317	13,785,176	703,044	2,177,179
Decrease (−)	−74,844	−16,295	−1,524,452	−70,450	+517,365	−39,953	−145,009

Cooney (Mogollon) district.[3]—The production of the Mogollon district in 1914 was 136,124 tons of ore, yielding $629,102 in gold and 1,410,327 ounces of silver, and a nominal quantity of lead, with a total value of $1,409,035, as compared with $619,886 in gold and 1,306,766 ounces of silver, nominal quantities of copper and lead, and a total value of $1,409,912 in 1913. The gold output of this district represented 54 per cent of the State yield of this metal, and the silver yield 79 per cent of the total silver output. The lead came from concentrates.

There were 12 producing mines in the district, as against 8 in 1913, and the tonnage increased from 115,739 tons to 136,124 tons. The average assay per ton in terms of recovered metal was 0.2236 ounce, or $4.62 in gold, and 10.36 ounces, or $5.73 in silver.

The Deadwood 15-stamp 70-ton concentration-cyanidation mill was operated on ore from the company's Deadwood mine and also on

[1] Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull. 380, p. 274, 1909. Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 18, 31, 34, 37, 62, 65, 218, 224, 225, 226, 228, 232, 245, 268–270, 1910.

[2] Lindgren, Waldemar, op. cit., pp. 37, 64, 66, 218, 268–271.

[3] Idem, pp. 18, 42, 43, 44, 47, 68, 69–71, 191–204.

custom ore from the Little Charlie, Eberle, Johnson, Gold Dust, and Pacific mines. The Ernestine 40-stamp concentration-cyanidation mill (with only minor changes in 1914) was operated continuously on ore from the company's Last Chance and Top mines and also on custom ore from the Little Charlie and Pacific mines. The Fanny or Socorro Mining & Milling Co.'s 30-stamp 195-ton concentration mill (with no additions to the mill in 1914) was operated steadily on ore from the company's mines and also on custom ore from the Pacific, Johnson, Queen, Alberta, Golden Eagle, and Deep Down mines. The Treasure mill was idle.

The shaft on the Deadwood property is 515 feet deep; on the Socorro Co.'s property, 1,100 feet deep. The Ernestine property is opened by a cross-cut tunnel, drifts, and winzes.

Mine production of Cooney or Mogollon district, Socorro County, N. Mex., 1904–1914.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	11,276	$61,880	79,014	422,308	.....	$162,484
1905	15,534	97,158	240,943	295,175	.....	288,735
1906	16,076	127,907	268,567	.....	.....	307,847
1907	20,698	105,413	418,338	150,000	.....	411,516
1908	19,546	116,418	278,939	.....	.....	264,256
1909	23,945	111,464	249,413	46	49	241,167
1910	50,514	304,210	595,669	.....	.....	625,871
1911	102,219	531,358	1,067,038	1,873	1,862	1,097,206
1912	101,361	524,858	1,093,158	184	386	1,197,197
1913	115,739	619,886	1,306,766	4,418	1,217	1,409,912
1914	136,124	629,102	1,410,327	.....	590	1,409,035
Increase (+) or decrease (−)	+20,385	+9,216	+103,561	−4,418	−627	−877

Magdalena (Kelly) district.[1]—Zinc is the principal metal produced in this district, and for 1914 the yield of that metal increased from 13,267,811 pounds (in terms of spelter and zinc in zinc-lead oxide) to 13,785,176 pounds; the other metals produced are more or less incidental to the production of zinc, and for 1914 there was a decreased output of gold, silver, copper, and lead.

Mine production of Magdalena district, Socorro County, N. Mex., 1904–1914.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	27,998	$154	5,024	3,200	688,209	17,991,780	$932,658
1905	30,411	.....	4,800	320,000	390,000	14,630,051	934,322
1906	35,478	.....	2,515	64,560	238,088	17,044,163	1,067,410
1907	3,630	13	4,406	24,045	707,981	676,356	85,158
1908	6,319	72	460	2,605	16,073	3,325,446	157,631
1909	30,724	435	17,925	170,792	3,085,279	12,878,241	860,051
1910	42,232	468	65,800	152,181	3,451,228	16,727,870	1,110,529
1911	25,840	352	42,773	77,448	2,123,039	9,930,281	694,266
1912	22,590	746	32,792	69,532	2,192,792	9,962,478	818,473
1913	47,647	3,942	40,212	278,252	2,198,030	13,267,811	911,069
1914	51,595	2,265	14,436	214,722	674,205	13,785,176	768,144
Increase (+) or decrease (−)	+3,948	−1,677	−25,776	−63,530	−1,523,825	+517,365	−142,925

[1] Dutton, C. E., Mount Taylor and the Zuni Plateau: U. S. Geol. Survey Sixth Ann. Rept., p. 194, 1885; Lindgren, Waldemar, op. cit., pp. 18, 19, 47, 51–53, 55, 214, 218, 220, 241–258; Weed, W. H., op. cit., p. 118.

The 150-ton wet-concentration mill (with special finishing process) of the Ozark Co. was operated steadily on zinc sulphide ore from the Graphic and Waldo mines, the product being zinc concentrate. In addition, copper sulphide, lead sulphide and oxide, zinc-lead sulphide and oxide, and zinc oxide ores were shipped to smelters. Zinc carbonate ore was shipped from the Ambrosia, Germany, and Kelly mines. Some lead oxide ore also was shipped from the Germany mine. The 60-ton magnetic separation and wet-concentration mill, formerly owned by the Tri-Bullion Co., sold in 1913 to the Empire Zinc Co., was being remodeled in 1914, but was not operated during the year.

San Andreas Mountains (Hembrillo) district.[1]—No yield was made from this district.

TAOS COUNTY.

Red River district.[2]—No output was made from this district in 1914, but development work was done on several properties.

Rio Hondo district.[3]—No work was done in this district in 1914.

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[1] Lindgren, Waldemar, op. cit., pp. 35, 74, 205, 234.
[2] Idem, pp. 35, 36, 42, 43, 68, 69, 70, 71, 82, 84–88.
[3] Idem, pp. 75, 83, 84.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN TEXAS IN 1914.[1]

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The following table shows the production of gold, silver, copper, lead, and zinc in Texas in 1913 and 1914:

Mine production of gold, silver, copper, lead, and zinc in Texas, 1913–1914.

Year.	Gold.		Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		*Pounds.*		*Pounds.*		
1913	16.45	$340	427,553	$258,242	34,665	$5,373	225,227	$9,910	652,607	$36,546	$310,411
1914	11.32	234	530,817	293,542	23,760	3,160	149,027	5,812	216,451	11,039	313,787
Increase (+) or decrease (−)	−5.13	−106	+103,264	+35,300	−10,905	−2,213	−76,200	−4,098	−436,156	−25,507	+3,376

The output of Texas mines during 1914 was $234 for gold, 530,817 fine ounces of silver, 23,760 pounds of copper, 149,027 pounds of lead, and 216,451 pounds of zinc (calculated as spelter recovered), with a total value of $313,787, as compared with $310,411 in 1913. The greater part of the silver came from the Presidio silver mine and 125-ton all-sliming, continous agitation, and filtration plant. Some of the silver, lead, and zinc, and all of the copper came from properties in the Van Horn district, Culberson County. The greater part of the lead and zinc came from the Sierra Blanca district, El Paso County.

TOTAL PRODUCTION OF TEXAS.

The table following gives the total production in Texas of gold, silver, copper, lead, and zinc from 1885 to 1914, inclusive.

[1] For discussion of the geology of the districts mentioned in the following pages the reader is directed to the bibliography appended to the report for 1912, in Mineral Resources, 1912, pt. 1, pp. 876–7, 1913, and to Survey Bulletin 507: The mining districts of the western United States, by J. M. Hill, with a geological introduction by Waldemar Lindgren, 1912.

Mine production of gold, silver, copper, lead, and zinc in Texas, 1885–1914.

Year.	Gold.	Silver.		Copper.		Lead.		Zinc.		Total value (commercial).
		Quantity.	Commercial value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Fine ounces.		*Pounds.*		*Pounds.*		*Pounds.*		
1885 *a*		*b e* 169,342	*c* $181,196							$181,196
1886		*b e* 191,873	*d* 189,954							189,954
1887		*b f* 235,999	231,279	(*g*)						231,279
1888		*h* 380,068	357,264							357,264
1889	*i* $6,828	*i* 323,438	304,032							310,860
1890	*j* 78	*j* 370,000	388,500	(*j*)		(*j*)				388,578
1891		*k* 375,000	371,250	*l* 42,000	$5,376	*l* 7,385	$318			376,944
1892		*m* 328,100	285,447							285,447
1893	*o* 2,662	*n* 349,400	272,532							275,194
1894	*no* 4,320	*n* 429,314	270,468							274,788
1895		*n* 450,000	292,500							292,500
1896	*n* 8,000	*n* 525,400	357,272			(*y*)				365,272
1897	*n* 7,400	*n* 404,700	242,820			(*y*)				250,220
1898	*n* 300	*n* 472,900	279,011			(*y*)				279,311
1899	*n* 6,900	*n* 520,000	312,000			(*y*)				318,900
1900	*n* 1,100	*n* 477,400	295,988							297,088
1901	*n* 600	*n* 472,400	283,440			(*y*)				284,040
1902		*n* 446,200	236,486			(*y*)				236,486
1903		*n* 454,400	245,376			(*y*)				245,376
1904	*pq* 186	*pq* 385,576	223,634			(*y*)				223,820
1905	*pr* 248	*pr* 387,506	236,379							236,627
1906	*ps* 1,592	*ps* 301,772	205,205			*p* 49,030	2,795	*z* 16,000	$976	210,568
1907	*pt* 9	*pt* 303,688	200,434			*p* 23,947	1,269	*p* 44,000	2,596	204,308
1908	(*pu*)	*pu* 444,336	235,498	*p* 28,364	3,744	*p* 65,833	2,765	*p* 35,957	1,690	243,697
1909	*pv* 314	*pv* 374,444	194,711	*p* 3,862	502	*p* 91,140	3,919			199,446
1910	*pw* 423	*pw* 380,322	205,374	*p* 3,157	401	*p* 65,068	2,863			209,061
1911	*px* 21	*px* 424,394	224,929			*p*122,800	5,526			230,476
1912	*p* 63	*p* 406,067	249,731	*p* 721	119	*p* 65,311	2,939	*p*238,000	16,422	269,274
1913	*p* 340	*p* 427,553	258,242	*p* 34,665	5,373	*p*225,227	9,910	*p*652,607	36,546	310,411
1914	*p* 234	*p* 530,817	293,542	*p* 23,760	3,160	*p*149,027	5,812	*p*216,451	11,037	313,787
Total	46,618	11,742,409		7,924,494	136,529	18,675	864,768	38,116	1,203,015	69,267	8,092,172

a U. S. Geol. Survey Mineral Resources, 1908, pt. 1, p. 541, 1909, and idem, 1910, pt. 1, p. 572, 1911. Report from Presidio Mining Co. says "mine operated continuously since 1884." Company report (1908) also says "mill was started Dec. 25, 1885, and operated steadily to date."

b Report of Director of the Mint for 1887, p. 238, being the report of Francis N. Holbrook, agent for the mint.

c U. S. Geol. Survey Mineral Resources, 1885, p. 201, gives $90,000 for combined production of Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming.

d U. S. Geol. Survey Mineral Resources, 1886, p. 105, gives $205,000 for combined production of Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming.

e Phillips, W. B., The Mineral Resources of Texas: Texas Dept. of Agr. Bull. 14, July–August, 1910, p. 22; gives 155,039 fine ounces, valued at $154,263, for 1882–1886.

f Rept. Director of the Mint estimate for 1887 is 193,364 ounces, valued at $250,000; U. S. Geol. Survey Mineral Resources, 1887, the same; Phillips, op. cit., gives 193,798 ounces.

g Mint agent says (pp. 237–238): "Ores of the Carrizo district (near Van Horn, Culberson County) * * * average about 54 ounces silver per ton and 6 to 20 per cent copper. Mines actually worked and shipping ore—Hazel, Sancho Panza, Llewellyn, Gracie."

h Holbrook, Rept. Director of Mint for 1888, pp. 22, 155. Director of Mint gives 232,031 ounces (p. 22) but gives the same (232,031 ounces) for 1889, p. 21.

i U. S. Geol. Survey Mineral Resources, 1889–1890, p. 49, being Eleventh Census figures. Director of the Mint for 1889 gives 232,031 ounces; mint agent gives 310,007 ounces; Phillips, 324,165 ounces.

j Yale, Chas. G., mint agent, Rept. Director of the Mint for 1890, pp. 20, 180, gives: Presidio mine, 5,596 tons, 163,952 ounces silver; Cibolo Creek, 4,618 tons, 119,071 ounces silver; Hazel, $83,000 silver, some copper. Chaouti (Chinati) mine (at Shafter) shipped 22,750 pounds of ore, averaging 26 ounces silver, ½ ounce gold, 31 per cent lead. Mentions Bonanza mine (Sierra Blanca district, El Paso County). Rept. Director of the Mint, p. 21, and U. S. Geol. Survey Mineral Resources, 1889–1890 give 300,000 ounces; Phillips, 300,690 ounces.

k Director of the Mint, U. S. Geol. Survey Mineral Resources, 1891, and Phillips for 1891.

l Mint agent, Rept. Director of the Mint, p. 220, gives 357,370 ounces silver, 42,000 pounds of copper (from 600 tons of ore from Hazel mine) and 7,358 pounds of lead (from 10.8 tons of ore from Bonanza mine).

m U. S. Geol. Survey Mineral Resources, 1893, p. 50, also Rept. Director of the Mint for 1893, p. 19, and subsequent reports. U. S. Geol. Survey Mineral Resources, 1892, and mint for 1892 give 310,000 ounces.

n U. S. Geol. Survey Mineral Resources, 1894, being estimate by Director of the Mint. Mint agent's figures for these years correspond closely with director's figures.

o Agent's figures, Director of the Mint.

p U. S. Geol. Survey Mineral Resources. Collected from the mines.

q Director of the Mint gives $2,300 gold and 469,600 ounces of silver.

r Director of the Mint gives $1,900 gold and 417,200 ounces of silver.

s Director of the Mint gives $3,400 gold and 277,400 ounces of silver.

t Director of the Mint gives $1,000 gold and 305,300 ounces of silver.

u Director of the Mint gives $500 gold and 447,000 ounces of silver.

v Director of the Mint gives $400 gold and 408,100 ounces of silver.

w Director of the Mint gives $400 gold and 364,400 ounces of silver.

x Director of the Mint gives $3,900 gold and 444,200 ounces of silver.

y Included with Washington, Oregon, Alaska, and South Dakota for 1896, 1897, 1898, 1899, 1901. Included with Oregon, Alaska, and South Dakota for 1902, 1903, and 1904.

z Smelter figures.

REDUCTION MILLS.

Mineral Resources for 1912, part 1, page 879, 1913, contained a complete list of the reduction mills in Texas in 1912, with description of equipment and process. Any changes in this list for 1914 have been noted in the text of the various counties, and reference should be made to the 1912 report for details of equipment.

REVIEW BY COUNTIES.[1]

BREWSTER COUNTY.

A little development work was done in the Alpine district. In this district is the Bird mine from which, in the past, some silver-bearing galena has been shipped to the El Paso smelter.[2]

BURNET COUNTY.[3]

For two years development work has been done on the Sheridan prospect, 8 miles northwest of Burnet, and the openings are now a 100-foot vertical shaft, and 16 prospect holes from 5 to 100 feet deep. Oxidization extends to a depth of 20 feet. Sample assays show copper, zinc, and silver. Machine drills and hoisting machinery have been added to the equipment.

CULBERSON COUNTY.[4]

The mining districts of Culberson County were included in El Paso County before 1911. From the Hazel mine, in the Van Horn district, shipments of crude ore and a small quantity of concentrate from the Sutton, Steele & Steele dry concentrator on the property were shipped to copper smelters until May, 1914, when the mine was closed. A quantity of the ore was shipped to the Sutton, Steele & Steele plant at Denver, Colo., a zinc concentrate being the product. This mine, in pre-Cambrian sandstone,[5] has been an important producer of silver-copper ore.[6]

EL PASO COUNTY.

In the Sierra Blanca district the 20-ton concentration plant (1 crusher, 2 sets rolls, screens, and 2 jigs) of the Southwestern Mines Co., on the Bonanza.[7] property, was operated from January to June and during September in 1914, the yield being a lead and a zinc concentrate.

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[1] In this section references to discussions of the geology of the several districts are given in the footnotes.
[2] Phillips, W. B., Lead ore in Burnet County, Tex.; Eng. and Min. Jour., vol. 77, p. 364, 1904.
[3] Phillips, W. B., op. cit., p. 394.
[4] Richardson, G. B., U. S. Geol. Survey Geol. Atlas, Van Horn folio (No. 194), 1913.
[5] Richardson, G. B., Reconnaissance of trans-Pecos Texas: Texas Univ. Mineral Survey Bull. 9, pp. 24–25, 1904.
[6] Von Streeruwitz, Trans-Pecos Texas: Texas Geol. Survey Third Ann. Rept., pp. 387–389, 1892. Von Streeruwitz, Report on the geology and mineral resources of trans-Pecos Texas: Texas Geol. Survey Second Ann. Rept., p. 699, 1891.
[7] Von Streeruwitz, W., Geology of trans-Pecos Texas: Texas Geol. Survey First Ann. Rept., pp. 223–224 1890.

KNOX COUNTY.

The copper prospects near Truscott, in the blue clays of the Permian beds,[1] were abandoned in 1913, and no prospecting or development work was done in 1914.

LLANO COUNTY.[2]

At the Heath mine,[3] a 50-ton cyanidation plant was completed but not operated, because, it is said, of shortage of cyanide.

PRESIDIO COUNTY.

Shafter district.[4]—The greater part of the total silver output of Texas has come from the Shafter district and chiefly from the Presidio mine, which has been operated steadily since 1884. The ore, which is chiefly silver chloride (horn silver), with which are associated more or less isolated patches of silver-bearing galena, was treated from 1884 to 1913 by pan-amalgamation, but in May, 1913, the mill was reconstructed into a 125-ton cyanidation plant, using the all-sliming process and continuous agitation and filtration. Operations were continuous in 1914.

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[1] Cummins, W. F., Notes on the geology of northwest Texas: Texas Geol. Survey Fourth Ann. Rept., pp. 232–238, 1893.
Phillips, W. B., Texas Geol. Survey Second Ann. Rept., p. 450, 1890.
Phillips, W. B., The Permian copper ores in Texas: Eng. and Min. Jour., Dec. 16, 1911, pp. 1181–1182.

[2] Auriferous and argentiferous copper ore in Llano County: Am. Inst. Min. Eng. Trans., vol. 5, p. 16, 1876–7. Comstock, T. B., Report on the geology and mineral resources of the central region of Texas: Texas Geol. Survey Second Ann. Rept., pp. 577–582, 1891. Also preliminary report on the geology of the central mineral region of Texas: Texas Geol. Survey First Ann. Rept., pp. 334–339, 1890. Dumble, E. T., The occurrence of gold in the Eocene deposits of Texas: Am. Inst. Min. Eng. Trans., vol. 44, 1912, or Bull. 70, October, 1912, and Eng. and Min. Jour., p. 836, Nov. 2, 1912. Hess, Frank L., Minerals of the rare-earth metals at Baringer Hill, Llano County, Tex.: U. S. Geol. Survey Bull. 340, pp. 286–294, 1908. Paige, Sidney, Preliminary report on pre-Cambrian geology and iron ores of Llano County, Tex.: U. S. Geol. Survey Bull. 430, pp. 256–268, 1910. Paige, Sidney, Mineral resources of Llano-Burnet region, Texas: U. S. Geol. Survey Bull. 450, 1911. Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Llano-Burnet folio (No. 183), 1912.

[3] McLaren, A., Gold and rare metal mining near Llano, Tex.: Salt Lake Min. Rev., vol. 14, No. 3, pp. 11–13, May 15, 1912. Paige, Sidney, U. S. Geol. Survey Bull. 450, pp. 70–72, 1911. Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Llano-Burnet folio (No. 183), p. 13, 1912.

[4] Phillips, W. B., Shafter silver district, Presidio County, Tex.: Eng. and Min. Jour., p. 1303, Dec. 31, 1910. Udden, J. A., The geology of the Shafter silver mine district, Presidio County, Tex.: Texas Univ. Mineral Survey Bull. 8, p. 54, 1904.

GOLD, SILVER, COPPER, AND LEAD IN SOUTH DAKOTA IN 1914.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the production of gold, silver, and lead in South Dakota in 1914, as reported from 30 productive mines, 10 of which were placers, amounted to $7,431,343. This is an increase of only $7,010 over the yield of 1913. The gold output in 1914 was 354,758.45 fine ounces, valued at $7,333,508, nearly 99 per cent of the total value. The increase in gold yield for the year was 687.60 fine ounces in quantity and $14,214 in value. The production of silver also increased from 172,702 to 176,642 fine ounces. Smelting ore from South Dakota carried no copper and only 3,897 pounds of lead, against 1,793 pounds of copper and 10,205 pounds of lead in 1913. The output of placer gold amounted to only 68 ounces. Some of the placer gold was sold for use in the arts.

The total quantity of ore mined and treated in 1914 was 2,019,262 short tons, averaging in recovered gold 0.17565 ounce, or $3.63 in gold per ton, as compared with 1,899,167 short tons, averaging 0.186 ounce, or $3.85 in gold in 1913; with 1,901,726 short tons, averaging 0.20 ounce, or $4.14 in gold, in 1912; with 1,946,127 short tons, averaging $3.187, in 1911; and with 1,523,929 short tons, averaging $3.543 in 1910. There were 2,017,882 tons treated in the mills of the State, yielding as bullion $7,273,702 in gold and 172,574 fine ounces of silver, valued at $95,433, an average recovery per ton of $3.605 in gold and $0.05 in silver, as compared with $3.81 in gold and $0.05 in silver in 1913, with $4.08 in gold and $0.06 in silver in 1912, and with $3.77 in gold and $0.05 in silver in 1911. The quantity of crude ore shipped to smelters amounted to 1,380 tons, having an average content in gold of 2.047 fine ounces, or $42.32 a ton, and of 2.94 ounces in silver.

Output of ore to gold and silver mills, with quantity of gold and silver contained in bullion produced in South Dakota in 1914, by processes.

Ore to gold and silver mills.	Process.	Gold in bullion.	Silver in bullion.
		Fine ozs.	*Fine ozs.*
1,588,000 short tons	Amalgamation	218,644.09	63,734
1,998,197 [a] do	Cyanidation	133,221.25	108,840
Total		351,865.34	172,574

[a] Includes 1,568,315 tons of tailings from part of ore amalgamated.

The consumption of quicksilver and cyanide in South Dakota mills in 1914 was 13,500 pounds of quicksilver,[1] 89,649 pounds of potassium cyanide,[2] and 425,397 pounds of sodium cyanide.[2]

[1] Represents 1 pound of mercury per 16.20 ounces of gold, or 1 pound of mercury per 117 tons of ore.
[2] Potassium and sodium cyanide were used at a ratio of 0.26 pound of cyanide per ton of ore or tailings treated, and for every pound used there was recovered 0.259 ounce of gold.

Mine production of gold, silver, copper, and lead in South Dakota in 1913 and 1914.

Year.	Number of mines producing.	Ore.	Gold.[a]		Silver.[a]		Copper.		Lead.		Total value.
			Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*		*Pounds.*		
1913	30	1,899,167	354,070.85	$7,319,294	172,702	$104,312	1,793	$278	10,205	$449	$7,424,333
1914	30	2,019,262	354,758.45	7,333,508	176,642	97,683	.....	.....	3,897	152	7,431,343
Increase (+) or decrease (−)	.....	+120,095	+687.60	+14,214	+3,940	−6,629	−1,793	−278	−6,308	−297	+7,010

[a] Includes placer production.

Production of gold and silver in South Dakota from 1876 to 1914, inclusive.

Year.	Gold.	Silver.		Total commercial value.
	Value.	Fine ounces.	Commercial value.	
1876	[a]$1,200,000	3,867	$4,486	$1,204,486
1877	[a] 2,000,000	6,187	7,424	2,007,424
1878	[a]2,250,000	7,734	8,894	2,258,894
1879	[a]2,500,000	7,734	8,662	2,508,662
1880	[b] 3,305,843	[d] 54,770	[g] 62,986	3,368,829
1881	[b] 4,000,000	54,141	61,179	4,061,179
1882	[b] 3,300,000	135,352	154,301	3,454,301
1883	[b] 3,200,000	116,016	128,778	3,328,778
1884	[b] 3,300,000	116,016	128,778	3,428,778
1885	[b] 3,200,000	77,344	82,758	3,282,758
1886	[b] 2,700,000	328,711	[h] 325,424	3,025,424
1887	[b] 2,400,000	417,656	[h] 409,303	2,809,303
1888	[b] 2,600,000	[d] 77,344	72,703	2,672,703
1889	[b] 2,900,000	[d] 50,000	47,000	2,947,000
1890	[b][c]3,200,000	[d] 100,000	105,000	3,305,000
1891	[b] 3,550,000	[d] 100,000	99,000	3,649,000
1892	[b] 3,700,000	[d] 60,000	52,200	3,752,200
1893	[d] 4,006,400	[d] 140,000	109,512	4,115,912
1894	[d] 3,868,155	[d] 58,973	37,153	3,905,308
1895	[d] 3,869,500	[d] 159,300	103,545	3,973,045
1896	[d] 4,969,800	[d] 229,500	156,060	5,125,860
1897	[d] 5,694,900	[d] 147,600	88,560	5,783,460
1898	[d] 5,699,700	[d] 152,300	89,857	5,789,557
1899	[d] 6,469,500	[d] 145,600	87,360	6,556,860
1900	[d] 6,177,600	[d] 536,200	[d] [i] 332,444	6,510,044
1901	[d] 6,479,500	[d] 78,000	[d] 46,800	6,526,300
1902	[d] 6,965,400	[d] 340,200	[d] 180,306	7,145,706
1903	[e] 6,826,700	[d] 221,200	[d] 119,448	6,946,148
1904	[e] 7,363,977	[e] 161,611	[j] 93,734	7,457,711
1905	[e] 6,989,492	[e] 182,749	[j] 111,477	7,100,969
1906	[e] 6,841,469	[e] 150,875	[j] 102,595	6,944,064
1907	[e] 4,138,189	[e] 93,895	[e] 61,971	4,200,160
1908	[e] 7,657,376	[e] 248,762	[e] 131,844	7,789,220
1909	[e] 6,577,836	[e] 194,273	[e] 101,022	6,678,858
1910	[e] 5,402,257	[e] 118,800	[e] 64,152	5,466,409
1911	[e] 7,439,874	[e] 203,755	[e] 107,990	7,547,864
1912	[e] 7,981,370	[e] 206,460	[e] 126,973	8,018,343
1913	[e] 7,319,294	[e] 172,702	[e] 104,312	7,423,606
1914	[e] 7,333,508	[e] 176,642	[e] 97,683	7,431,191
Total	185,287,640	5,832,669	4,213,674	189,501,314

[a] Black Hills, S. Dak., by the Black Hills Mining Men's Association, 1904.

[b] Emmons, S. F., Progress of the precious-mineral industry in the United States since 1880; U. S. Geol. Survey Mineral Resources, 1892, p. 71, 1893; Estimate of the Director of the Mint.

[c] A canvass of the mines by the Eleventh Census gives $3,091,137.

[d] U. S. Geol. Survey Mineral Resources: Estimated by the Director of the Mint.

[e] U. S. Geol. Survey Mineral Resources: Collected by the United States Geological Survey from the mines.

[f] Report of the Director of the Mint for 1880, p. 192, gives for the fiscal year 1879: Gold, $2,420,000; silver, $10,000.

[g] Report of the Director of the Mint for 1880, p. 162, records first output (in latter part of 1879) of silver from the Florence silver chlorination mill and of shipments to Omaha of silver ore.

[h] Due to production of Iron Hill lead-silver mine. Report Director of the Mint for 1887, p. 197.

[i] Due to the treatment at the Deadwood and Delaware smelter of accumulated silver-bearing ore (of the Golden Reward mine) not desirable to treat by chlorination process. Franklin R. Carpenter, Report Director of the Mint for 1900, p. 185.

[j] Previous figures of U. S. Geol. Survey give, respectively, $92,522, $110,381, $101,086.

Source of gold and silver produced in South Dakota in 1914.

Source.	Number of mines.	Ore.	Gold.		Silver.		Total value.
			Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine ounces.*		*Fine ounces.*		
Siliceous ore	18	2,019,255	354,688.88	$7,332,070	176,241	$97,461	$7,429,531
Lead ore	2	7	1.60	33	390	216	249
Total	20	2,019,262	354,690.48	7,332,103	176,631	97,677	7,429,780
Placer mines	10	.....	67.97	1,405	11	6	1,411
Grand total	30	2,019,262	354,758.45	7,333,508	176,642	97,683	7,431,191

MINING INDUSTRY IN 1914.

CONDITIONS.

The Homestake mines and mills were operated continuously in 1914. The Golden Reward, Reliance, and Trojan mills were operated steadily. The new Mogul mill was placed in operation early in 1914 and continued active throughout the year on company and custom ore. The Bismarck mill, in operation since April, 1913, was closed in September, 1914. The Deadwood-Standard mill was operated for a short period by lessees. Some ore was shipped from the Rattlesnake-Jack mine, in the Bear Butte district, and from the Heidelberg and Monarch mines, in the Two Bit district.

A small production of placer gold was made in Custer, Lawrence, and Pennington counties. In Pennington County some production was made at the First National lode mine and mill, Hill City, and at the Otho lode mine and mill, Keystone.

REDUCTION MILLS.

Mineral Resources for 1913, Part I, pages 43–45, contains a complete list of the reduction mills in South Dakota in 1913, with description of equipment and process. Changes in this list for 1914 have been noted in the text of the various counties, and reference should be made to the 1913 report for details of equipment.

REVIEW BY COUNTIES.

CUSTER COUNTY.

Mine production of gold, silver, and copper in Custer County, S. Dak., from 1904 to 1914.

Year.	Number of mines producing.	Ore.	Gold.[a]	Silver.[a]	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1904	4	1,900	$6,491	121	.....	$6,560
1905	5	16	706	3	38	714
1906	2	16	687	3	.....	689
1907	1	33	332	3	.....	334
1908	2	470	1,533	4	.....	1,535
1909	1	400	1,311	21	.....	1,322
1910	.....	.....	.....	.....	.....	.....
1911	5	.....	309	4	.....	311
1912	5	75	1,187	3	.....	1,189
1913	5	5	194	1	1,503	428
1914	2	17	206	5	.....	209
Increase (+) or decrease (−)	−3	−12	+12	+4	−1,503	−219

[a] Includes both deep and placer mines.

A small lot of gold-silver ore was shipped from Custer. A small yield of placer gold was recovered by sluicing and rocker near Custer.

LAWRENCE COUNTY.[1]

Mine production of gold, silver, copper, and lead in Lawrence County, S. Dak., from 1904 to 1914.

Year.	Number of mines producing.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	44	1,801,524	$7,346,986	161,216	.....	.....	$7,439,282
1905	19	1,826,177	6,955,690	182,597	.....	.....	7,065,979
1906	27	1,771,377	6,816,196	150,537	.....	22,719	6,918,351
1907	22	1,470,154	4,134,667	93,830	.....	.....	4,196,595
1908	17	1,927,844	7,650,523	248,686	.....	23,046	7,783,295
1909	17	1,699,260	6,561,628	191,044	3,977	1,512	6,661,553
1910	19	1,522,986	5,380,795	118,716	.....	14,136	5,445,523
1911	16	1,940,719	7,408,356	203,350	.....	64,311	7,519,025
1912	19	1,901,310	7,875,401	206,356	.....	22,845	8,003,338
1913	20	1,899,162	7,317,320	172,688	290	10,205	7,422,117
1914	21	2,019,016	7,331,638	176,585	.....	2,766	7,429,397
Increase (+) or decrease (−)	+1	+119,854	+14,318	+3,897	−290	−7,439	+7,280

[a] Includes both placer and deep mines.

Output of Homestake mine, 1909–1914, inclusive.

Year.	Ore milled.	Bullion recovered.	Value per ton.	Dividends.
	Short tons.			
June 1, 1909, to June 1, 1910	1,237,381	$4,498,751	$3.6357	$982,900
June 1, 1910, to June 1, 1911	1,468,263	5,251,454	3.5766	1,310,400
June 1, 1911, to Dec. 31, 1911	888,057	3,601,152	4.1205	764,400
Calendar year 1912	1,528,923	6,600,953	4.3174	1,310,400
Calendar year 1913	1,540,961	6,186,652	4.0148	2,146,224
Calendar year 1914	1,587,774	6,160,161	3.87975	2,210,203

For the calendar year 1914 the Homestake Co.'s public report says:

The operations of the Homestake Mining Co. for the year 1914 have been normal, there being no interruption of any kind to continuous operation. The property is in excellent condition. * * * The principal betterments for the year consist of a completely equipped central boiler plant of six 600-horsepower boilers; an electric generating station having a maximum capacity of 4,000 kilovolt amperes, consisting of two units of steam turbines, condensing, direct connected to generators; a compound condensing steam hoist, designed to handle two 6-ton skips from a maximum depth of 4,000 feet, skips dumping direct into two No. 8 Gates crushers; a compound condensing air compressor, with a capacity of 3,000 cubic feet free air.

The recreation building, containing theater with a seating capacity of 1,000, library, swimming pool, gymnasium, bowling alleys, billiard and amusement rooms, was opened to the public August 31, 1914.

The B. and M. shaft was sunk from the 1,550-foot level to the 1,700-foot level, and the Golden Star shaft from the 1,250-foot level to the 1,400-foot level, and 17,809 feet of drifting was done during the year.

The ore reserves in the mine are large and represent many years' supply to the present crushing capacity, and we are now saving 94 per cent of the values.[2]

[1] For information on the geology of this county see Irving, J. D., Ore deposits of the northern Black Hills: U. S. Geol. Survey Bull. 225, pp. 123–140, 1904. Irving, J. D., and Emmons, S. F., Economic resources of northern Black Hills: U. S. Geol. Survey Prof. Paper 26, pp. 53–212, 1904.

[2] Rept. Homestake Mining Co., from Jan. 1 to Dec. 31, 1914. See also Min. and Sci. Press, Mar. 27, 1915, pp. 499–500; Eng. and Min. Jour., 1915, p. 618.
Clark, A. J., Notes on Homestake metallurgy; Am. Inst. Min. Eng. Trans. No. 103, July, 1915, pp. 1381–1400. Also Min. and Sci. Press, July 17, 1915, pp. 87–91, and Min. Eng. World, July 10, 1915, pp 49–53.

Sinking on the Oro Hondo property, south of the Homestake, reached a depth of 1,400 feet.

In the Bald Mountain area and the Portland district, the Golden Reward group was operated continuously, both on company account and by lessees, and oxidized ore was shipped to the company's mill and to the smelter at Omaha. Experimentation was continued at the mill at Deadwood and at the 75-ton Wedge roaster at the Astoria shaft toward the solution of the problem of treating the sulphide or "blue" ores. Custom ore from the Alameda, Clinton, Heidelberg, Snowstorm, and Rattlesnake Jack mines was treated at the Golden Reward mill. The new Mogul mill at Terry was placed in operation early in 1914 and operated continuously on ore from the company's Mark Twain, Lucille, McDonald, Mogul, and North Star mines, and on custom ore from the Alameda and Clinton mines. The Trojan mine and mill were operated during the entire year, oxidized siliceous ore being treated at the mill and the sulphide ore being sent to the smelter at Omaha. The New Reliance mine and mill were operated continuously. The ore treated from this mine is both oxidized and sulphide. Custom ore from the Dakota mine was treated at the mill. The Deadwood-Standard mine and mill were operated for a period by lessees.

In the Bear Butte (or Galena) district, gold ore was shipped from the Rattlesnake Jack mine to custom mill and smelter. A 50-ton cyanidation mill was under construction on this property. Development work was done on the Brasch mine. The semipyritic smelter in this district remained idle, as did the Gilt Edge 150-ton dry-crushing concentration mill.

Several cars of ore carrying commercial quantities of gold and some silver were shipped from the Monarch mine, situated between Two Bit and Whitewood gulches.

In the Maitland district, development work was done on the Echo mine.

In the Yellow Creek area, the dry-crushing cyanidation plant of the Wasp No. 2 was operated continuously. According to the annual report [1] of this company, operating at Flatiron—

> During 1914 there were treated 176,140 tons of ore, having an average value of $2.015 gold and $0.287 silver per ton. There was saved 73.31 per cent of the gold and 34.77 per cent of the silver, a total of $1.533 per ton. Costs totaled $226,683, or $1.287 per ton. * * * Mining in open cuts, using a steam shovel for stripping as much as 20 feet of overburden to obtain 20 feet of ore, cost $0.661 per ton; and milling, which consists of crushing the hard quartzite to pass a screen having openings 0.25 by 0.75 inch, followed by simple leaching with cyanide, cost $0.591 per ton. * * *

The company's records for 1911–1914 shows:

Year.	Tonnage.	Yield.	Value per ton.	Dividends.
	Short tons.			
1911	160,860	$286,160	$1.779	$60,000
1912	158,840	308,175	1.940	85,000
1913	127,680	219,333	1.718	55,000
1914	176,140	269,979	1.533	30,000
Totals and average value	623,520	1,083,647	1.738	230,000

[1] See Min. and Sci. Press, Mar. 20, 1915, p. 463. Also Eng. and Min. Jour., Mar. 20, 1915, p. 552.

The Bismarck Co.'s mill was operated until September, 1914. The public report [1] of this company shows that—

During the year ending July 31, 1914, the Bismarck Co., at Flatiron, mined and milled 79,036 tons of ore containing a gross value, by assay, of $114,831 (an average of $1.453 per ton). From January 1 to July 31, 1914, * * * 42,880 tons had a gross assay value of $65,326 (an average of $1.52 per ton), and, of this, $55,113 was recovered. The recovery, made entirely by simple leaching of the dry-crushed product, was $1.285 per ton, equal to an extraction of 84.54 per cent. During this seven-month period the company earned a slight profit; during the remainder of the year it sustained a loss. The costs for the entire year were at an average of $1.253 per ton. This * * * cost covers all of the expenditures for mining, including stripping of 25 to 30 feet of overburden, tramming, milling, and general expenses, on an output of 250 tons per day * * *. Of the costs, $0.694 is charged to milling and $0.599 to mining. The stripping costs $0.1518 per ton of ore mined. During only three months of the year was the mill operated at full capacity * * *. In the mill 0.349 pound of cyanide was consumed for each ton of ore treated. Zinc consumption amounted to 0.396 pound per ton or $33.27 per $1,000 of bullion recovered.

In the Rawlings district, near Tinton, a small yield of placer gold was made from several placers by sluicing.

PENNINGTON COUNTY.

Mine production of gold, silver, copper, and lead in Pennington County, S. Dak., from 1904 to 1914.

Year.	Number of mines producing.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	16	1,511	$10,500	274	.....	.....	$10,657
1905	8	11,218	33,096	149	.....	.....	33,186
1906	6	9,281	24,586	335	.....	.....	24,810
1907	7	969	3,190	62	.....	.....	3,231
1908	8	1,235	5,320	72	.....	.....	5,358
1909	13	4,481	14,897	3,208	114,408	.....	31,438
1910	7	943	21,462	84	.....	.....	21,508
1911	16	5,408	31,209	401	.....	.....	31,422
1912	16	341	14,782	101	.....	.....	14,844
1913	5	.....	1,780	13	.....	.....	1,788
1914	8	229	1,664	52	.....	1,131	1,737
Increase (+) or decrease (−)	+3	+229	−116	+39	.....	+1,131	−51

[a] Includes both deep and placer mines.

Near Mystic, on Castle Creek, the Castle Creek Hydraulic Gold Mining Co.'s dredge remained idle. Assessment work was done on several lode properties.

At Hill City the mine and mill on the Forest City property were operated for a time. The 50-ton mill of the Limelight Co., west of Hill City, was operated during July. The mine was operated eight months. The sinking of the shaft of the Dakota-Calumet property was continued for a time in the early part of 1914, but work was later suspended.

In the Hornblende district, near Rochford, assessment work was done on several properties.

At Keystone development work was done on several properties. The 100-ton amalgamation and concentration mill of the Otho Co. was operated part of the year.

[1] See Min. and Sci. Press, Oct. 24, 1914, p. 663. Also Eng. and Min. Jour., Sept. 26, 1914, p. 592.

Several small sluice mines were operated on Battle, Rapid, and Spring creeks. A 50-ton Chilean mill was under construction on the Grand View property on Rapid Creek.

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GOLD, SILVER, AND COPPER IN WYOMING IN 1914.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the production of gold, silver, and copper in the State of Wyoming in the calendar year 1914 was only $7,387, as against $84,474 in 1913. The yield of all three metals decreased heavily, particularly copper. There were 15 producing mines, of which 8 were deep and 7 were placer.

The quantity of ore sold or treated was only 423 tons, as compared with 4,236 tons in 1913. Deep mines yielded $3,165 in gold, 109 ounces of silver, and 17,421 pounds of copper. Placer gold production amounted to $1,841 in 1914, as compared with $1,407 in 1913.

Mine production of gold, silver, and copper in Wyoming in 1913 and 1914.

Year.	Ore.	Gold.[a]		Silver.[a]		Copper.		Total value.
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*		
1913	4,236	1,169.90	$24,184	957	$578	385,239	$59,712	$84,474
1914	423	242.17	5,006	116	64	17,421	2,317	7,387
Decrease (−).	−3,813	−927.73	−19,178	−841	−514	−367,818	−57,395	77,087

[a] Includes placer production.

The table on pages 248–249 shows the total output of gold, silver, and copper in Wyoming since 1867.

Production of gold, silver, and copper in Wyoming from 1842 to 1914, inclusive.

Year.	Gold.	Silver.		Copper.		Total value.
	Value.	Fine ounces.	Commercial value.[q]	Pounds.[s]	Value.	
1842–1867	[a] Small, unknown.					
1867	[a] $8,600	[o] 70	$90			$8,690
1868	[a] 77,500	[o] 620	802			78,302
1869	[a] [c] 155,000	[o] 1,240	1,603			156,603
1870	[b] [c] 155,000	[o] 1,240	1,603			156,603
1871	[c] 155,000	[o] 1,240	1,603			156,603
1872	[d] 100,000	[o] 800	1,034			101,034
1873	[e] 50,000	[o] 400	517			50,517
1874	[f] 25,000	[o] 200	259			25,259
1875	[g] 10,000	[m] 100	124			10,124
1876	[h] 10,000	[m] 100	116			10,116
1877	[h] 10,000	[m] 100	120			10,120
1878	[h] 10,000	[m] 100	115			10,115
1879	[h] 10,000	[m] 100	112			10,112
1880	[i] 20,000	[m] 100	115			20,115
1881	[j] 5,000	[m] 100	113			5,113
1882	[j] [k] 5,000	[m] 240	274	[u] [w] 100,000	$19,100	24,374
1883	[j] 4,000	[m] 1,440	1,598	[v] [w] 962,468	158,807	164,405
1884	[j] 6,000	[m] 100	111			6,111
1885	[l] 10,000	[m] 100	107			10,107
1886	[m] 7,500	[m] 100	99			7,599
1887	[m] 7,500	[m] 100	98			7,598
1888	[m] 7,500	[m] 420	395	[w] 232,819	39,114	47,009
1889	[m] 7,500	[m] 240	226	[w] 100,000	13,500	21,226
1890	[m] 7,500	[m] 100	105			7,605
1891	[m] 7,500	[m] 100	99			7,599
1892	[m] 7,500	[m] 100	87			7,587

[a] Raymond, R. W., Mining statistics west of the Rocky Mountains for 1869, 1870. The Sweetwater district, Wyoming, pp. 325–328.

[b] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1870, 1872. Wyoming, pp. 334–335.

[c] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1871, 1873. Wyoming, pp. 372–376.

[d] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1872, 1873. Wyoming, pp. 306–307, see also p. 3.

[e] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1874, p. 8, 1875.

[f] Estimate by Charles W. Henderson. See Raymond, R. W., idem, pp. 7–8.

[g] Estimate by Charles W. Henderson. See Raymond, R. W., Mineral resources west of the Rocky Mountains for 1875, p. 335, 1877. "Sweetwater district nearly idle." The total gold for 1867–1875 ($736,100) represents the output of the Sweetwater (Atlantic City, South Pass, Lewiston) district. These figures are much lower than generally quoted. They are the figures of Rossiter W. Raymond, who has explained in his reports herein quoted the manner in which he collected them. The source of the generally quoted figures ($5,050,000) is W. C. Knight (The mining districts in Wyoming: Wyoming Univ., Agr. Coll. Dept., Bull. 14, October, pp. 123–124, 1893), but Knight says: "The only estimate of the output from this region is one which has been generally circulated, but upon what basis the estimate is made or who is the author I am unable to find out." Henry C. Beeler, former State geologist (Mineral resources of Wyoming, pp. 18–19, State Board of Immigration, Cheyenne, Wyo., 1907), says: "The amount of gold produced rom 23 properties in this district since its discovery is $3,728,000. The gold from placers in the early days of the district * * * can only be estimated and is placed at from $2,000,000 to $3,000,000;" and (on p. 3) he adds: "Gold mines were first worked at South Pass, Fremont County, in 1867, since which date the industry has amounted to something each year. The annual production has fluctuated from $25 000 to $125,000, the total being estimated at $4,000,000." Mr. Beeler (oral communication) says these figures are borne out by statements of some of the old residents of this district, including stage drivers, bankers, etc. C. E. Jamison, State geologist (Geology and mineral resources of a portion of Fremont County, Wyo., Bull. 2, series B, p. 80, Cheyenne, 1911), gives "estimated output of the mines of the South Pass district as $5,863,000."

The earliest report at hand is that of Samuel Aughey (Ann. Rept. Territorial Geologist to the Governor of Wyoming, January, 1886, pp. 12–15, Laramie, Wyo., 1886), who says: "Placer grounds on Spring Gulch, at Miner's Delight, are still successfully worked every spring while the water lasts. Up to date these grounds have yielded over $400,000 in gold. The Miner's Delight * * * when worked in the palmy days of mining * * * produced at least $200,000."

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Beeler, H. C. (State geologist), A brief review of the South Pass gold district, Fremont County, Wyo., 18 pp., Nov. 1, 1908.

Production of gold, silver, and copper in Wyoming from 1842 to 1914, inclusive—Continued.

Year.	Gold.	Silver.		Copper.		Total value.
	Value.	Fine ounces.	Commercial value.	Pounds.	Value.	
1893	*m* $7,500	*m* 100	$78			$7,578
1894	*m* 7,500	*m* 100	63			7,563
1895	*m* 7,500	*m* 100	65			7,565
1896	*j* 14,300	*j* 100	68			14,368
1897	*j* 11,200	*j* 100	60			11,260
1898	*j* 5,300	*j p* 100	59	*x* 233,044	$28,897	34,256
1899	*j* 29,200	*j p* 400	240	*x* 3,104,827	530,925	560,365
1900	*j* 34,200	*j* 200	124	*x* 4,203,776	697,827	732,151
1901	*j* 12,700	*j p* 21,400	12,840	*y* 2,698,712	450,685	476,225
1902	*j* 38,800	*j* 5,000	2,650	*y* 889,228	108,486	149,936
1903	*j* 3,600	*j p* 200	108	*y* 1,023,189	140,177	143,885
1904	*n* 17,305	*n* 4,647	*r* 2,695	*t x* 3,565,629	456,401	476,401
1905	*n* 26,745	*n* 3,655	*r* 2,230	*t y* 2,530,531	394,763	423,738
1906	*n* 6,521	*n* 136	*r* 92	*t z* 106,177	20,492	27,105
1907	*n* 9,344	*n* 3,715	2,452	*t z* 3,026,004	605,201	616,997
1908	*n* 7,959	*n* 3,998	2,119	*a a t* 2,416,197	318,938	329,016
1909	*n* 4,086	*n* 1,754	912	*bb t* 433,672	56,377	61,375
1910	*n* 3,199	*n* 1,478	798	*cc t* 217,127	27,575	31,572
1911	*n* 19,200	*n* 725	384	*dd t* 130,499	16,312	35,896
1912	*n* 22,235	*n* 265	163	*ee t* 25,080	4,138	26,536
1913	*n* 24,184	*n* 957	578	*f f* 385,239	59,712	84,474
1914	*n* 5,005	*n* 116	*n* 64	*n* 17,421	*n* 2,317	7,387
Total	1,196,184	58,795	40,367	26,400,739	4,149,744	5,386,295

h Estimate by Charles W. Henderson. Based on opening of placers in Wyoming adjacent to Black Hills, S. Dak.
i Burchard, H. C., Rept. Director Mint for fiscal year 1880, p. 8, 1881.
j Mineral Resources U. S., U. S. Geol. Survey. Estimate of the Director of the Mint.
k See Burchard, Rept. Director Mint, p. 594.
l Estimate by Charles W. Henderson, partly by elimination of production of other States.
m Estimate by Charles W. Henderson.
n Mineral Resources U. S., U. S. Geol. Survey. Collected by the U. S. Geological Survey from the mines.
o Estimated on basis of fineness of gold and silver, Sweetwater district.
p A knowledge of the quantity of silver in the copper ore of the Encampment district shows that the figures for silver are too low for 1898, 1899, 1900, and 1903, the balance giving a high output of silver for the State for these four years; the figures are too high for 1901.
q Except for the period 1867–1874, inclusive, when coining value ($1.2929) was approximately commercial value.
r Previous figures of the U. S. Geological Survey are, respectively, $2,661, $2,208, and $91.
s From Copper, Mineral Resources United States, U. S. Geological Survey, being copper output as reported from smelters and refineries.
t The copper output as reported by the mines to the Survey for the years 1904–1912 is—

	Pounds.		Pounds.
1904	3,527,008	1910	222,339
1905	2,394,008	1911	118,584
1906	24,000	1912	27,570
1907	2,257,650		
1908	2,452,049	Total	11,515,747
1909	492,539		

The smelter figures are 12,450,916 pounds.

u See Kirchhoff, C., jr., The copper industry of the United States: U. S. Geol. Survey, Mineral Resources for 1881–82, p. 216 (for output), p. 229 (for history of discovery of copper in the State), 1883.
v For figures see op. cit. for 1883–84, p. 329, U. S. Geol. Survey, 1885.
w From Hartville district, Laramie County.
x From Encampment district, Carbon County, showing beginning in 1898.
y From Encampment district and Douglas Creek (Holmes, New Rambler) district (in Albany County adjoining), showing beginning of output of New Rambler property.
z Encampment, Douglas Creek, Hartville, and Copper Mountain.
aa Encampment, Hartville, and Copper Mountain.
bb Encampment and Hartville.
cc Douglas Creek and Copper Mountain.
dd Encampment, Douglas Creek, and Hartville.
ee Douglas Creek and Hartville.
f f Hartville.

Source of mine production of gold and silver in Wyoming in 1913 and 1914.

Source.	Number of mines.	Ore.	Gold.		Silver.		Total value.
			Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine ounces.*		*Fine ounces.*		
Siliceous ore	5	345	153.11	$3,165	30	$16	$3,181
Copper ore	3	78	.....	.....	79	44	44
Total deep mines, 1914	8	423	153.11	3,165	109	60	3,225
Deep mines, 1913	6	4,236	1,101.84	22,777	942	569	23,346
Increase (+) or decrease (−)	+2	−3,813	−948.73	−19,612	− 833	−509	−20,121
Placer mines, 1914	7	.....	89.06	1,841	7	4	1,845
Placer mines, 1913	9	.....	68.06	1,407	15	9	1,416
Increase (+) or decrease (−)	− 2	.....	+ 21.00	+ 434	− 8	− 5	+ 429
Total deep and placer mines, 1914.	15	423	242.17	5,006	116	64	5,070

MINING INDUSTRY IN WYOMING IN 1914.

The principal producing district in Wyoming in 1914 was the Atlantic City (or South Pass) district, Fremont County, which yielded mill bullion, shipping ore, and placer bullion, but there was a heavy decrease as compared with 1913. If the power and freight problem in this district can be solved, the production may again be of considerable importance.

Copper ore was shipped from Hartville, Platte County. A small quantity of placer gold was recovered in the Hurricane district, Crook County. A car of copper ore was shipped from the Elk Mountain district, Carbon County, and one from the Casper Mountain district, Natrona County. The construction of an amalgamation mill in the Seminoe district, Carbon County, as the result of a trial shipment for tests in 1914, promises a yield of gold from this district in 1915. Resumption of work on the Rambler copper-platinum-palladium property, at Holmes, Albany County, promises a yield from this district in 1915.

REVIEW BY COUNTIES.

In the following review the footnote references indicate publications containing information on the geology of the respective regions.

ALBANY COUNTY.[1]

At the Rambler property, at Holmes, from which considerable copper ore, and concentrates containing platinum and palladium have been shipped in the past, the concentrating plant was rebuilt and a Peck centrifugal concentrator was installed. The mill was put into operation November 10, 1914, and an appreciable quantity

[1] Emmons, S. F., Platinum in copper ores in Wyoming: U. S. Geol. Survey Bull. 213, pp. 94–97, 1903. Kemp, J. F., Platinum in the Rambler mine, Wyoming: U. S. Geol. Survey, Mineral Resources for 1902, pp. 244–250, 1904. Platinum in Wyoming: Eng. and Min. Jour., Mar. 4, 1911, p. 460. Concentration of platiniferous copper ore at the Rambler mine, Wyo.: Metall. and Chem. Eng., February, 1911, pp. 75–78.

of ore was milled, but the product of copper-gold-silver-platinum-palladium concentrates was not marketed in 1914.

Assessment work and development work was done on several claims in the Centennial district.

The following table shows the production of Albany County for those years for which figures are available:

Mine production of gold, silver, and copper in Albany County,[a] Wyo., 1868–1914.

Year.	Ore.	Gold.		Silver.	Copper.
		Placer.	Deep mines.		
	Short tons.			*Fine ounces.*	*Pounds.*
1868–1893		[b] $40,000	[b] $189,000		
1901–1912		[c] 945			
1901–1903					[c] 900,532
1907					[c d] 24,350
1909–1912	[c e] 3,071		[c] 2,108	[b] 3,213	[c] 700,567
1913					
1914					
Total					1,625,449

[a] Chiefly Douglas Creek district.

[b] Knight, W. C., The mining districts of Albany County: Wyoming Univ. Agr. College Dept. Bull. 14, p. 128, October, 1893. (Probably too high, considering total production of Wyoming for these years.)

[c] Mineral Resources records.

[d] Beeler, H. C., Mineral Resources of Wyoming, State Board of Immigration, Cheyenne, Wyo., p. 27, 1907, gives 828,700 pounds for production of the Rambler mine to date (1907).

[e] For one year tonnage of concentrates used instead of crude ore, giving therefor tonnage and contents of material smelted. The concentrates were little better than the original crude ore.

BIG HORN COUNTY.[1]

Assessment work was done on several placer and lode claims in this district.

CARBON COUNTY.[2]

A car of copper ore was shipped from the Elkhorn mine, on Elk Mountain, 12 miles from Overland. There is a vertical shaft 190 feet deep and 1,000 feet of drifts on this property. The ore carries gray copper.

In the Seminoe district, 60 miles north of Rawlins, a car of free-milling sulphide gold-silver ore was shipped from the Penn mine to the Black Hawk sampler, Black Hawk, Gilpin County, Colo., and after being sampled was milled at the U. P. R. amalgamation-concentration mill. A 20-stamp mill was under construction early in 1915. The mine is opened by a 310-foot vertical shaft, 400 feet of drifts, and 340 feet of adits.

The Penn-Wyoming mines and smelter, near Encampment, from which much of the copper output of Wyoming has come, were idle.

The following table shows the production of the Encampment district from the year of first output, 1898, to 1914.

[1] Darton, N. H., U. S. Geol. Survey Geol. Atlas, Bald Mountain-Dayton folio (No. 141) and Cloud Peak-Fort McKinney folio (No. 142), 1906; Geology of the Bighorn Mountains: U. S. Geol. Survey Prof. Paper 51, 1906. Fisher, C. A., Geology and water resources of Bighorn Basin, Wyo., U. S. Geol. Survey Prof. Paper 53, 1906.

[2] Spencer, A. C., Mineral resources of the Encampment copper region, Wyoming: U. S. Geol. Survey Bull. 213, pp. 158–162, 1903.

Spencer, A. C., Copper deposits of the Encampment district, Wyoming: U. S. Geol. Survey Prof. Paper 25, 107 pages, 1904.

See also Spencer, A. C., Reconnaissance examination of the copper deposits at Pearl, Colo.: U. S. Geol. Survey Bull. 213, pp. 163–169, 1903.

Mine production of gold, silver, and copper in the Encampment[a] district, Carbon County, Wyo., from 1898 to 1914.

Year.	Ore.	Gold.	Silver.		Copper.		Total value.
			Fine ounces.	Commercial value.	Pounds.	Value.	
	Short tons.						
1898	[b] 2,484	[b] $497	[b] 314	$185	[c] 233,044	$28,897	$29,579
1899	[b] 33,095	[b] 6,619	[b] 4,183	2,510	[c] 3,104,827	530,925	540,054
1900	[b] 44,808	[b] 8,962	[b] 5,663	3,511	[c] 4,203,776	697,827	710,300
1901	[b] 28,766	[b] 5,753	[b] 3,636	2,182	[cd] 2,698,712	450,685	458,620
1902	[b] 2,536	[b] 507	[b] 321	170	[c d] 237,892	29,023	29,700
1903	[b] 8,250	[b] 1,650	[b] 1,043	563	[c] 773,993	106,037	108,250
1904	41,370	6,593	4,483	2,600	[e] 3,527,008	451,457	460,650
1905	28,039	4,678	3,549	2,165	[e] 2,385,628	372,158	379,001
1906	60	.....	.....	.....	[c] 24,000	4,632	4,632
1907	25,950	4,802	2,982	1,968	[e] 2,206,065	441,213	447,983
1908	18,851	6,181	3,123	1,655	[e] 2,367,666	312,532	320,368
1909	150	.....	.....	.....	[e] 33,431	4,346	4,346
1910	.....	.....	.....	.....	.....	.....	.....
1911	20	.....	21	11	[e] 4,738	592	603
1912	.....	[f] 27	.....	.....	.....	.....	27
1913	.....	[f] 424	8	5	.....	.....	429
1914	[g] 47	141	26	14	4,439	590	745
Total	234,426	46,834	29,352	17,539	21,805,219	3,430,914	3,495,260

Average per ton of deep mines: Gold, $0.199; silver, 0.129 ounce; copper, 93 pounds, or 4.62 per cent.

[a] Including various small yields from other districts of Carbon County (being the output of Carbon County).
[b] Estimated by Charles W. Henderson.
[c] Smelter figures.
[d] The Encampment production for 1901–2 is the total Wyoming copper production less the Douglas Creek, Albany County, copper production. The Douglas Creek figures are available only for the two years combined. This combined production has been subtracted from the total Wyoming production for 1902, none being subtracted from the 1901 figures. In either event, the total pounds of copper produced in each camp would be unchanged.
[e] Mine figures.
[f] Placer output.
[g] Saratoga and Seminoe districts.

CONVERSE COUNTY.

In 1914 no work was done at the Saul's Camp property, near Esterbrook, from which, in 1913, it was reported that some copper-sulphide ore, carrying gold and silver, and an iron-sulphide ore, carrying nickel, had been opened by a 90-foot shaft, 30 feet of drifts, and 700 feet of diamond drill holes.

CROOK COUNTY.

Sluicing in the Hurricane district, northwest of Tinton, South Dakota, resulted in a small placer output.

Assessment work only was done on properties in the Bear Lodge district,[1] near Sundance.

FREMONT COUNTY.

From 4 deep mines and 4 placers in the Atlantic City district there was a production of $4,334 in gold and 32 ounces of silver, valued at $18, as compared with $23,276 in gold and 115 ounces of silver in 1913; with $21,804 in gold and 146 ounces of silver in 1912; with $18,672 in gold and $161 in silver for 1911; and with a total value of $1,786 in 1910 for the county.

[1] Darton, N. H., U.S. Geol. Survey, Geol. Atlas, Sundance folio (No. 127), 1905.

Atlantic City (South Pass) district.[1]—The production of gold in the Atlantic City district was 87 per cent and of silver 28 per cent of the State totals for these metals. During 1911–1913 there had been a reopening of mines in this district (which was known as the Sweetwater district in 1842–1875[2]) and an increasing production was shown for these years, but in 1914 the principal producing property was idle, because of the high cost of power. At the Duncan mine, the 30-ton amalgamation-cyanidation mill was operated (using only amalgamation equipment) intermittently for 60 days. A few tons of dump ore from the Burr property was milled in a 3½-foot Huntington mill. A few tons of ore from the Irish Jew mine were treated in the Burr Huntington mill, with cyanide tanks, for testing the results of amalgamation and cyanidation on the ore. A small shipment of ore, carrying an appreciable quantity of gold, was made from the Irish Jew mine to the Globe smelter, Denver. Other operations in the nature of "clean-ups" around idle mills in the district, recovered a small quantity of gold. A 50-ton amalgamation-cyanidation mill was under construction on the Helen G. property, for the treatment of the yield of several other properties in different parts of the district. Assessment work was done on the Carissa mine, and the mine was kept unwatered. The Miners Delight mine was unwatered, but no work was done.

The X. L. Dredging Co.'s placer property was operated for a period by hydraulicking and a quantity of gold was recovered. Small sluicing operations in the district resulted in the recovery of a small quantity of gold.

Copper Mountain district.—No work was done on the prospects in this district in 1914.

Gold placers on Wind and Bighorn Rivers.[3]—No yield was made from these deposits.

JOHNSON COUNTY.[4]

Assessment work was done in the Bull Camp and Big Goose districts.

LARAMIE COUNTY.

Assessment work was done in the Silver Crown district.

LINCOLN COUNTY.

Surface work was done on the Golden Eagle prospect, near Kemmerer, showing indications of gold, silver, copper, and lead.

NATRONA COUNTY.

A car of copper ore was shipped from the surface of the Nettie M. claim, in the Casper Mountain district, 10 miles south of Casper.

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[1] For discussion of geology and description of mines see Trumbull, L. W., Atlantic City gold mining district, Fremont County, Wyo.: Wyoming State Geologist Rept. Bull. 7, ser. B, 1914.

[2] See note to table of production of gold, silver, and copper in Wyoming, 1842–1914.

[3] For discussion of geology see Schrader, F. C., Gold placers on Wind and Bighorn Rivers, Wyoming: U. S. Geol. Survey Bull. 380, pp. 127–145, 1915.

[4] See Darton, N. H., U. S. Geol. Survey Geol. Atlas, Bald Mountain-Dayton folio (No. 141) and Cloud-Peak-Fort McKinney folio (No. 142), 1906; also Geology of the Big Horn Mountains, U. S. Geol. Survey Prof. Paper 51, 1906.

PARK COUNTY.

Some little development work was done in the Sunlight and Kirwin [1] districts of Park County.

PLATTE COUNTY.[2]

A small quantity of copper ore was shipped from the Sunrise iron mine, near Sunrise, in the Hartville district.[3] Development work was done on the Copper Bottom and Green Hope mines.

The following table shows the production of the Hartville district since its discovery in 1881:

Mine production of the Hartville district, Laramie County Wyo., from 1882 to, 1914.[a]

Year.	Ore.	Silver.		Copper.		Total value.
		Quantity.	Commercial value.	Quantity.	Value.	
	Short tons.	*Fine ounces.*		*Pounds.*		
1882		[b] 140	$160	100,000	$19,100	$19,260
1883		[b] 1,340	1,487	962,468	158,807	160,294
1888		[b] 320	301	232,819	39,114	39,415
1889		[b] 140	132	100,000	13,500	13,632
1882–1889	[c] 4,651	[b] 1,940	2,080	1,395,287	230,521	232,601
1907–1909, 1911–12	[d] 539	[e] 342	188	172,875	23,127	23,315
1913	[d] 964	831	502	385,239	59,712	60,214
1914 [f]						
Total	6,154	5,113	2,770	1,953,401	313,360	316,130

[a] For basis of figures, see Kirchhoff, C., jr., The copper industry of the United States: U. S. Geol. Survey Mineral Resources for 1881–82, pp. 216, 229, 1883; idem for 1883–84, p. 329, 1885. Knight, W. C., The Hartville district: Wyoming Univ. Agr. Coll. Dept. Bull. 14, pp. 135–136, October, 1893.

[b] Estimated by Charles W. Henderson on Mr. Kirchhoff's statement that ore contained ⅛ to ¼ ounce of silver for every per cent of copper.

[c] Estimated on basis of 15 per cent copper per ton (Kirchhoff).

[d] Mineral Resources records collected from the mines.

[e] Mineral Resources records 1911–12. Estimated on 1911–12 record for 1907, 1908, 1909.

[f] Not given, only one mine, small production.

UINTA COUNTY.[4]

There was no production in Uinta County in 1914.

[1] See Hewett, D. F., The ore deposits of Kirwin, Wyo.: U. S. Geol. Survey Bull. 540, pp. 121–132, 1914.

[2] Laramie County prior to 1913.

[3] Smith, W. S. T., U. S. Geol. Survey Geol. Atlas, Hartville folio (No. 91), 1903. Ball, S. H., Copper deposits of the Hartville uplift, Wyoming: U. S. Geol. Survey Bull. 315, pp. 93–107, 1907.

[4] Schultz, A. R., Gold developments in central Uinta County, Wyo., and at other points on Snake River: U. S. Geol. Survey Bull. 315, pp. 71–88, 1907.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO IN 1914.[1]

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

GENERAL STATEMENT.

The total value of the production of gold, silver, copper, lead, and zinc in Colorado in 1914, as reported from 866 mines, of which 35 were placers, amounted to $33,460,126, as compared with $35,450,585 in 1913, a decrease of $1,990,459. Of the total value 59 per cent represented gold, the output of which was $19,883,105, an increase of $1,736,189, as compared with the yield of 1913. There was a decrease in silver output of 529,190 fine ounces. The production of copper, which is merely incidental to the recovery of other metals, decreased 588,653 pounds. The quantity of lead produced in 1914 was 74,211,898 pounds, a decrease of 13,685,875 pounds. The quantity of zinc produced was 96,774,960 pounds, a decrease of 22,571,469 pounds.

ORE PRODUCTION IN 1914.

The output of ore sold or treated in 1914 from Colorado mines was 2,677,526 short tons, a decrease of 57,340 tons, as compared with the production of 1913.

The output of siliceous and dry ores was 2,157,762 tons, a decrease of 3,696 tons. The output of copper ores was 12,196 tons, a decrease of 4,359 tons; the production of lead ores was 193,087 tons, a decrease of 12,687 tons; and the output of zinc ores increased 4,361 tons, from 141,295 tons in 1913 to 145,656 tons in 1914. There were 1,192 tons of copper-lead ores produced in 1914, a decrease of 5,225 tons. The output of lead-zinc ores was 167,633 tons, a decrease of 35,734 tons. The combined output of zinc and lead-zinc ores showed a decrease of 31,373 tons.

During 1914 there were treated at amalgamating and cyaniding mills, including also a very small quantity at chlorinating mills, with or without concentration equipment (including all the custom mills of the State), 1,630,640 tons of ore having an average recovery as bullion or precipitates of 0.375 ounce gold and 0.415 ounce silver per ton.

[1] For discussion of the geology of the districts mentioned in the following pages the reader is directed to the bibliography appended to the report for 1912, in Mineral Resources, 1912, pt. 1, pp. 704–705, 1913, and to U. S. Geol. Survey Bull. 507, The mining districts of the western United States, by J. M. Hill, with a geological introduction by Waldemar Lindgren, 1912.

From 1,630,640 tons treated at amalgamating, cyaniding, and chlorinating mills, and from 378,743 tons sent to concentration and separation mills, a total to both classes of mills of 2,009,383 tons (75 per cent of the total tonnage treated, as compared with 76 per cent in 1913), were produced 188,770 tons of concentrates—ratio 10.6 to 1—with an average total value of $35.95 a ton, as compared with $39.94 a ton in 1913.

Ore milled in 1914, in terms of metals recovered as bullion or by concentration, averaged 0.3625 ounce gold and 1.36 ounces silver per ton, 0.047 per cent copper, and 0.885 per cent lead.

Crude ore shipped to all kinds of smelters amounted to 668,143 tons, averaging 0.30 ounce gold and 9.06 ounces silver per ton, 0.35 per cent copper, and 2.96 per cent lead.

Crude ore and concentrates shipped to all kinds of smelters therefore amounted to 856,913 tons, averaging 0.372 ounce gold and 9.47 ounces silver per ton, 0.39 per cent copper, and 4.33 per cent lead.

In 1914 there were 35 productive placers in Colorado which yielded $642,360 in gold and 7,321 fine ounces, valued at $4,049, in silver, a total of $646,409 in gold and silver, compared with $411,296 in 1913, with $427,025 in 1912, with $321,704 in 1911, with $398,140 in 1910, with $461,508 in 1909, and with $186,058 in 1908.

Mine production of gold, silver, copper, lead, and zinc in Colorado, in 1913 and 1914.[a]

Year.	Number of producing mines.	Ore.	Gold.[b]	Silver.[b]	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	858	2,734,866	$18,146,916	9,325,255	7,227,826	87,897,773	119,346,429	$35,450,585
1914	866	2,677,526	19,883,105	8,796,065	6,639,173	74,211,898	96,774,960	33,460,126
Increase (+) or decrease (−)	+8	−57,340	+1,736,189	−529,190	−588,653	−13,685,875	−22,571,469	−1,990,459

[a] Revised table of production of gold, silver, copper, lead, and zinc, from beginning of mining in Colorado, to 1914, will be issued in a separate publication, The history of Colorado mine production (now in preparation).

[b] Includes placer production.

GOLD.

The total production of gold for Colorado in 1914 was 961,845.19 fine ounces, valued at $19,883,105, against 877,857.06 fine ounces, valued at $18,146,916, in 1913, an increase of 83,988.13 fine ounces in quantity and of $1,736,189 in value.

The Cripple Creek district, with an increase of $1,091,113, produced $11,996,116 in gold, which was 60 per cent of the output of gold from all sources.

The San Juan region, in Dolores, La Plata, Ouray, San Juan, and San Miguel counties showed a decrease of $101,826. There was a decrease of $186,393 in La Plata, of $149,135 in San Juan, of $14,455 in San Miguel, and of $4,459 in Dolores, but an increase of $252,616 in Ouray. Other counties showing an increased output of gold were Teller, Summit, Park, Lake, Gunnison, Clear Creek, Chaffee, and Boulder, but notable decreases were made in Gilpin, Mineral, Custer, and Hinsdale.

Siliceous and dry ores, which made nearly 86 per cent of all the ore sold or treated, yielded 893,819.63 fine ounces, valued at

$18,476,892, or nearly 93 per cent of all the gold production. A little more than 3 per cent came from lead ores, less than 1 per cent from copper ores, less than 1 per cent from zinc and lead-zinc ores, and a negligible per cent from copper-lead ores. A little over 3 per cent came from placers.

The output of placer gold in 1914 was 31,074.16 fine ounces, valued at $642,360, an increase of $233,820. Summit County, with 4 dredges and 8 placers, produced nearly 95 per cent of the placer yield. The greater part of the remainder came from sluicing operations in Park, Moffat, and Chaffee counties, and from dredging operations in Gunnison County. There were small placer yields in Costilla, Douglas, Montrose, and Routt counties.

Source of mine production of gold in Colorado in 1914, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Boulder	.....	4,561.96	12.28	191.26	.....	9.60	.....	4,775.10
Chaffee	30.29	6,879.72	1.86	9,143.13	.....	16.63	.....	16,071.63
Clear Creek	.....	21,665.62	1,098.35	1,054.25	0.41	.74	139.56	23,958.93
Costilla	8.56	.....	.....	.....	.....	.....	.....	8.56
Custer	.....	155.75	4.75	2.28	.....	.....	.....	162.78
Dolores	.....	168.67	83.30	130.53	.....	.....	3.20	385.70
Douglas	6.77	.....	.....	.....	.....	.....	.....	6.77
Eagle	.....	2,059.64	10.12	8.22	.....	.....	205.03	2,283.01
Fremont	.....	1.73	69.67	.....	.....	.....	.....	71.40
Garfield	.....	116.25	.....	.....	.....	.....	.....	116.25
Gilpin	.....	26,230.11	666.73	829.66	.....	19.13	.....	27,745.63
Grand	.....	.15	.....	.....	.....	.....	.....	.15
Gunnison	212.07	404.00	.....	5.00	.....	.....	9.40	630.47
Hinsdale	.....	1.99	4.65	1.58	.....	.....	.....	8.22
Lake	.....	58,184.58	1,210.88	14,303.94	.90	.....	2,318.64	76,018.94
La Plata	.....	6,119.06	.25	.....	.....	.03	.....	6,119.34
Mineral	.....	860.89	.....	72.94	.....	.....	.....	933.83
Moffat	214.59	.....	.....	.....	.....	.....	.....	214.59
Montrose	21.04	.....	.53	.....	.....	.....	.....	21.57
Ouray	.....	58,528.90	25.72	69.66	.93	.56	4.39	58,630.16
Park	1,128.78	2,095.77	.....	40.04	.....	.....	.....	3,264.59
Pitkin	.....	20.46	.....	.....	.....	.....	.....	20.46
Rio Grande	.....	22.93	.....	.....	.....	.....	.....	22.93
Routt	12.63	.....	.....	.....	.....	.....	.....	12.63
Saguache	.....	4.99	1.00	745.67	.....	46.46	.70	798.82
San Juan	.....	20,737.29	53.79	3,582.08	.....	195.76	28.66	24,597.58
San Miguel	.....	102,297.52	.....	11.54	.....	.....	.....	102,309.06
Summit	29,439.43	2,389.55	.....	333.46	.....	.....	181.55	32,343.99
Teller	.....	580,312.11	.....	.....	.....	.....	.....	580,312.11
Total 1914	31,074.16	893,819.64	3,243.88	30,525.24	2.24	288.91	2,891.13	961,845.19
Total 1913	19,763.12	817,065.19	7,615.92	26,845.88	73.92	1,709.99	4,783.04	877,857.06
Increase (+) or decrease (−)	+11,311.04	+76,754.45	−4,372.04	+3,679.36	−71.68	−1,421.08	−1,891.91	+83,988.14

SILVER.

The yield of silver in Colorado in 1914 was 8,796,065 fine ounces, valued at $4,864,224, as against 9,325,255 fine ounces, valued at $5,632,454 in 1913, a decrease of 529,190 fine ounces in quantity and of $768,230 in value.

Lake County showed for 1914 an increase of 410,512 ounces and the output was 43 per cent of the State yield, as compared with 36.5 per cent in 1913. Notable increases in output were made in Boulder,

Chaffee, Custer, Eagle, Ouray, Saguache, San Miguel, and Teller counties, and notable decreases in Clear Creek, Gunnison, Hinsdale, La Plata, Mineral, Park, Pitkin, San Juan, and Summit counties.

In the production of silver, 11 counties, ranking in the order named, Lake, San Miguel, Mineral, Ouray, San Juan, Pitkin, Clear Creek, Boulder, Chaffee, Gilpin, and Eagle, furnished 95 per cent of the total.

Siliceous and dry ores yielded 6,584,493 fine ounces, or nearly 75 per cent of the silver output; lead ores, 1,532,943 ounces, or 18 per cent; copper ores, 173,845 ounces, or nearly 2 per cent; lead-zinc ores, 414,298 ounces, or nearly 5 per cent; copper-lead ores, 82,119 ounces, or less than 1 per cent. A negligible percentage came from zinc ores and from placers.

Source of mine production of silver in Colorado in 1914, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Boulder		152,857	184	116,335		42,841		312,217
Chaffee	7	147,462	674	99,139		24,960		272,242
Clear Creek		188,902	16,811	85,673	530	19	53,452	345,387
Costilla	2							2
Custer		13,518	603	1,854				15,975
Dolores		18,073	23,336	43,819			1,298	86,526
Eagle		99,738	235	12,614			14,493	127,080
Fremont		9	1,051	6				1,066
Garfield		80						80
Gilpin		111,835	13,515	19,588		299		145,237
Grand		617		1,130				1,747
Gunnison	65	7,363		38,665			12,943	59,036
Hinsdale		478	1,236	4,273				5,987
Lake		2,919,217	109,774	481,334	398		300,107	3,810,830
La Plata		59,832	383			29		60,244
Mineral		615,391		343				615,734
Moffat	11							11
Montrose	7		510					517
Ouray		527,551	1,385	62,823	118	1,734	678	594,289
Park	206	6,292		13,184		533		20,215
Pitkin		109,514		262,022			1,350	372,886
Rio Grande		16						16
Routt	5							5
Saguache		11	1,179	12,142		4,887	74	18,293
San Juan		232,580	2,969	247,763		6,817	3,788	493,917
San Miguel		1,269,150		11,311				1,280,461
Summit	7,018	14,951		18,925			26,115	67,009
Teller		89,056						89,056
Total, 1914	7,321	6,584,493	173,845	1,532,943	1,046	82,119	414,298	8,796,065
Total, 1913	4,563	6,270,758	223,108	1,645,186	21,950	491,058	668,632	9,325,255
Increase (+) or decrease (−)	+2,758	+313,735	−49,263	−112,243	−20,904	−408,939	−254,334	−529,190

COPPER.

The output of copper in Colorado in 1914 decreased in quantity from 7,227,826 pounds to 6,639,173 pounds, and in value from $1,120,313 to $883,010. Copper production was reported from 23 counties in 1914.

As usual, Lake County was the leading producer of copper, yielding nearly 36 per cent of the State output in 1914; Ouray was second, with nearly 13 per cent, and San Juan was third, with 12 per cent. Gilpin, Clear Creek, Dolores, San Miguel, and Chaffee followed in

order. These eight counties combined produced over 92 per cent of the total.

Siliceous and dry ores yielded 4,395,772 pounds, or 66 per cent, of the copper output; copper ores, 1,330,056 pounds, or 20 per cent; lead ores, 746,212 pounds, or 11 per cent; copper-lead ores, 97,672 pounds, or over 1 per cent; lead-zinc ores, 69,026 pounds, or 1 per cent. A negligible percentage came from zinc ores.

Source of mine production of copper in Colorado in 1914, by kinds of ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	4,789	955	11,185	.....	7,387	.....	24,316
Chaffee	159,474	21,942	93,760	.....	44,320	.....	319,496
Clear Creek	262,604	73,042	31,929	.....	215	.....	367,790
Custer	2,429	750	302	.....	.....	.....	3,481
Dolores	11,837	329,801	8,640	.....	.....	.....	350,278
Eagle	24,624	1,687	536	.....	.....	1,258	28,105
El Paso	.....	2,644	.....	.....	.....	.....	2,644
Fremont	1,222	190,652	43	.....	.....	.....	191,917
Garfield	128	.....	.....	.....	.....	.....	128
Gilpin	463,236	250,152	12,530	.....	661	.....	726,579
Gunnison	356	.....	153	.....	.....	10,679	11,188
Hinsdale	200	15,953	945	.....	.....	.....	17,098
Lake	1,827,800	359,025	144,690	49	.....	51,346	2,382,910
La Plata	11,931	13,729	.....	.....	378	.....	26,038
Mineral	32,304	.....	282	.....	.....	.....	32,586
Montrose	.....	32,414	.....	.....	.....	.....	32,414
Ouray	839,641	6,048	6,900	386	592	471	854,038
Park	3,223	.....	2,780	.....	2,020	.....	8,023
Pitkin	11,657	.....	56,080	.....	.....	.....	67,737
Saguache	.....	3,090	16,176	.....	16,517	.....	35,783
San Juan	415,848	28,172	353,086	.....	25,582	2,492	825,180
San Miguel	322,272	.....	1,833	.....	.....	.....	324,105
Summit	197	.....	4,362	.....	.....	2,780	7,339
Total, 1914	4,395,772	1,330,056	746,212	435	97,672	69,026	6,639,173
Total, 1913	4,110,475	1,701,666	566,401	1,556	640,795	206,933	7,227,826
Increase (+) or decrease (−)	+285,297	−371,610	+179,811	−1,121	−543,123	−137,907	−588,653

LEAD.

The production of lead (in terms of lead in lead bullion and in zinc-lead oxide) in Colorado in 1914 was 74,211,898 pounds, valued at $2,894,264, as against 87,897,773 pounds, valued at $3,867,502, in 1913, a decrease of 13,685,875 pounds in quantity and of $973,238 in value.

There were marked increases in the production of Boulder, Chaffee, Custer, La Plata, Pitkin, and Saguache counties. Decreases of note were made in Clear Creek, Dolores, Eagle, Gilpin, Gunnison, Hinsdale, Lake, Mineral, Ouray, Park, San Juan, San Miguel, and Summit counties.

In rank, Lake County led, with 26,784,615 pounds; Pitkin was second, with 23,233,230 pounds; San Juan was third, with 5,199,000 pounds; San Miguel was fourth, with 4,039,769 pounds; Chaffee was fifth, with 3,690,359 pounds; Clear Creek was sixth, with 2,435,692 pounds; Ouray was seventh, with 2,119,564 pounds; and Summit, Mineral, and Eagle followed in order. There was a decrease of 12,687 tons in the quantity of lead ores produced and a decrease of 35,734 tons in that of lead-zinc ores. Siliceous and dry ores yielded 19,150,122 pounds, or nearly 26 per cent of the lead output; lead

ores, 41,239,726 pounds, or nearly 56 per cent; lead-zinc ores, 13,341,468 pounds, or nearly 18 per cent; copper and copper-lead ores combined, 468,091 pounds, or less than 1 per cent.

Source of mine production of lead in Colorado in 1914, by kinds of ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	56,151	.....	432,158	.....	35,512	.....	523,821
Chaffee	2,167,263	.....	1,321,474	.....	142,168	59,454	3,690,359
Clear Creek	898,405	28,174	975,775	281	762	532,295	2,435,692
Custer	4,106	786	4,800	.....	.....	.....	9,692
Dolores	31,586	937	254,293	.....	.....	205,207	492,023
Eagle	15,682	33	53,514	.....	.....	1,108,156	1,177,385
Fremont	.....	.....	308	.....	.....	.....	308
Gilpin	320,116	544	177,332	.....	1,726	.....	499,718
Grand	365	.....	1,198	.....	.....	.....	1,563
Gunnison	7,640	.....	252,829	.....	.....	57,505	317,974
Hinsdale	817	.....	4,906	.....	.....	.....	5,723
Lake	6,153,563	51,992	10,473,293	11,041	.....	10,094,726	26,784,615
La Plata	11,308	.....	.....	.....	102	.....	11,410
Mineral	1,376,351	.....	25,444	.....	.....	.....	1,401,795
Ouray	1,697,823	.....	415,772	1,169	907	3,893	2,119,564
Park	40,775	.....	125,234	.....	2,145	.....	168,154
Pitkin	169,925	.....	23,016,165	.....	.....	47,140	23,233,230
Saguache	79	1,800	419,832	.....	108,424	4,737	534,872
San Juan	2,215,355	12,664	2,815,318	.....	79,415	76,248	5,199,000
San Miguel	3,937,870	.....	101,899	.....	.....	.....	4,039,769
Summit	44,942	.....	368,182	.....	.....	1,152,107	1,565,231
Total, 1914	19,150,122	96,930	41,239,726	12,491	371,161	13,341,468	74,211,898
Total, 1913	24,056,425	173,746	39,397,770	140,426	812,071	23,317,335	87,897,773
Increase (+) or decrease (−)	−4,906,303	−76,816	+1,841,956	−127,935	−440,910	−9,975,867	−13,685,875

ZINC.[1]

In 1914 the marketed zinc ores from Colorado contained 96,774,960 pounds of recoverable zinc (figured as spelter and zinc in zinc oxide), valued at $4,935,523, as compared with 119,346,429 pounds, valued at $6,683,400, in 1913. In 1914 the quantity of zinc produced was 22,563,062 more pounds than that of lead, and the value was $2,041,259 more than the value of lead and $71,299 more than the value of silver.

Zinc ores furnished 56,294,706 pounds, or 58 per cent of the total zinc yield; lead-zinc ores, 37,531,495 pounds, or nearly 39 per cent; and siliceous and dry ores, 2,948,759 pounds, or 3 per cent.

Lake County produced 81 per cent of the zinc yield of the State, with an output of 78,763,334 pounds, a decrease of 15,079,523 pounds for the year. Leadville zinc carbonate shipments, which in 1911 were only 83,905 tons, of 31 per cent zinc, in 1912 were 142,782 tons of 29.2 per cent zinc, and in 1913 were 135,760 tons of 27.45 per cent zinc, amounted to 113,881 tons of 24.3 per cent zinc in 1914; the zinc sulphide sold ore treated in 1914 increased from 97,704 tons of 23 per cent zinc in 1913 to 111,947 tons of 21.2 per cent zinc.

[1] For interesting discussion of zinc smelting and treatment of residues see Leslie, H. E., Zinc smelting at Bartlesville, Okla.; National Zinc Co., Bartlesville; Collinsville smelter of the Bartlesville Smelting Co., Hillsboro, Ill.; Rose Lake smelter of the Granby Co.; and Mineral Point smelter at Depue, Ill.; Min. and Sci. Press, vol. 109, pp. 44–49, July 11, 1914. Also see Stone, George C. (chief engineer New Jersey Zinc Co.), Belgian furnaces in zinc smelting; Min. and Sci. Press, Dec. 13, 1913, pp. 931–932. Stone, George C., Spelter—Manufacture and properties: Min. and Sci. Press, Nov. 14, 1914, pp. 754–759. Zinc smelter's roasting furnaces: Eng. and Min. Jour., Feb. 27, 1915, pp. 420–421.

Increased production of zinc was made in Chaffee, Eagle, Gilpin, and Gunnison counties, and appreciable decreases were made in Clear Creek, Dolores, Mineral, Ouray, Park, Pitkin, Saguache, San Juan, San Miguel, and Summit counties. After Lake County, Eagle and Summit counties are, respectively, second and third in the output of zinc.

Zinc output from concentrates in 1914 amounted to 31,419,916 pounds, and in crude ore shipped direct to 65,355,044 pounds.

The following tables show the quantity of zinc ore and concentrates:

Zinc ore and concentrates as marketed at the mine or mill,[a] in Colorado in 1914, by counties and districts, in short tons.

County and district.	Classification.	Quantity.	Average crude assay of zinc.
			Per cent.
Chaffee (ore and concentrates), Custer (ore), Gunnison (ore), Park (ore), Pitkin (ore), Saguache (ore).	Ore and concentrates	4,575	38.36
Lake	Zinc (lead) sulphide ore[b]	136,705	21.18
	Zinc cargonate ore	114,860	24.28
Eagle and Summit (ore and concentrates)	Ore and concentrates	17,073	43.73
Clear Creek (concentrates, ore, and middlings) and Gilpin (middlings).	Concentrates, ore, and middlings	1,713	39.35
San Juan region: Dolores (ore), Ouray (ore and concentrates), San Juan (concentrates).	Ore and concentrates	2,376	36.71
Total	Ore, concentrates, and middlings	251,565	24.70
SUMMARY.			
Lake	Crude ore	225,828	22.74
All other counties	Ore, concentrates, and middlings	25,737	41.83
Total	do	251,565	24.70
Total carbonate ore	Crude ore	114,860	24.34
Total sulphide ore	Ore, concentrates, and middlings	136,705	25.00

[a] Tonnage of crude ore and contents as shipped to custom plants at Denver and Canon City, not the product from these mills, in order to conceal individual production.

[b] The bulk concentrated at Canon City, Pueblo, and Denver; the remainder to zinc smelters and zinc oxide plants, chiefly in Kansas and Oklahoma. Concentrates range from 40 to 50 per cent zinc and are shipped to Kansas, Oklahoma, Illinois, Wisconsin, and eastern points.

Source of mine production of zinc in Colorado in 1914, by kinds or ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Zinc ores.	Lead-zinc ores.	Total.
Chaffee	1,960,851	61,597	150,729	2,173,177
Clear Creek	12,530	4,574	1,050,210	1,067,314
Custer		4,470		4,470
Dolores			366,549	366,549
Eagle		161,002	7,361,096	7,522,098
Gilpin	12,980			12,980
Gunnison			525,000	525,000
Lake		55,680,382	23,082,952	78,763,334
Ouray	21,562	8,084	14,962	44,608
Park		57,940		57,940
Pitkin		52,194	93,237	145,431
Saguache			8,941	8,941
San Juan	940,836		30,341	971,177
Summit		264,463	4,847,478	5,111,941
Total, 1914	2,948,759	56,294,706	37,531,495	96,774,960
Total, 1913	6,686,586	66,305,374	46,354,469	119,346,429
Increase (+) or decrease (−)	−3,737,827	−10,010,668	−8,822,974	−22,571,469

OUTPUT OF ORE AND METAL CONTENT.

Subdivision of crude ore sold or treated in Colorado in 1914, by counties, in short tons.

County.	Dry and siliceous gold and silver ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	12,716	13	1,792	.....	70	.....	14,591
Chaffee	53,062	259	7,455	104	514	304	61,698
Clear Creek	79,420	941	3,159	7	1	17,838	101,366
Custer	731	12	108	19	.....	.....	870
Dolores	682	3,502	1,841	.....	.....	880	6,905
Eagle	3,233	7	277	1,023	.....	44,837	49,377
El Paso	.....	25	.....	.....	.....	.....	25
Fremont	23	682	1	.....	.....	.....	706
Garfield	73	.....	.....	.....	.....	.....	73
Gilpin	50,006	2,004	821	.....	8	.....	52,839
Grand	4	.....	6	.....	.....	.....	10
Gunnison	4,134	.....	799	.....	.....	1,085	6,018
Hinsdale	25	65	28	.....	.....	.....	118
Lake	271,210	4,037	46,388	143,848	.....	81,980	547,463
La Plata	4,843	239	.....	.....	1	.....	5,083
Mineral	27,771	.....	181	.....	.....	.....	27,952
Montrose	.....	66	.....	.....	.....	.....	66
Ouray	103,816	63	1,635	14	5	27	105,560
Park	992	.....	854	101	11	.....	1,958
Pitkin	8,506	.....	109,197	90	.....	207	118,000
Rio Grande	8	.....	.....	.....	.....	.....	8
Saguache	9	51	1,149	.....	264	15	1,488
San Juan	99,529	230	16,261	.....	318	1,650	117,988
San Miguel	495,514	.....	228	.....	.....	.....	495,742
Summit	2,032	.....	907	450	.....	18,810	22,199
Teller	939,423	.....	.....	.....	.....	.....	939,423
Total, 1914	2,157,762	12,196	193,087	145,656	1,192	167,633	2,677,526
Total, 1913	2,161,458	16,555	205,774	141,295	6,417	203,367	2,734,866
Increase (+) or decrease (−)	−3,696	−4,359	−12,687	+4,361	−5,225	−35,734	−57,340
Average recovered value in gold and silver per ton	$10.25	$13.38	$7.66	$0.004	$43.11	$1.72	$9.00

Content of dry and siliceous gold and silver ores sold or treated in Colorado in 1914, by counties.

	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	12,716	4,561.96	152,857	4,789	56,151	.....
Chaffee	53,062	6,879.72	147,462	159,474	2,167,263	1,960,851
Clear Creek	79,420	21,665.62	188,902	262,604	898,405	12,530
Custer	731	155.75	13,518	2,429	4,106	.....
Dolores	682	168.67	18,073	11,837	31,586	.....
Eagle	3,233	2,059.64	99,738	24,624	15,682	.....
Fremont	23	1.73	9	1,222	.....	.....
Garfield	73	116.25	80	128	.....	.....
Gilpin	50,006	26,230.11	111,835	463,236	320,116	12,980
Grand	4	.15	617	.....	365	.....
Gunnison	4,134	404.00	7,363	356	7,640	.....
Hinsdale	25	1.99	478	200	817	.....
Lake	271,210	58,184.58	2,919,217	1,827,800	6,153,563	.....
La Plata	4,843	6,119.06	59,832	11,931	11,308	.....
Mineral	27,771	860.89	615,391	32,304	1,376,351	.....
Ouray	103,816	58,528.90	527,551	839,641	1,697,823	21,562
Park	992	2,095.77	6,292	3,223	40,775	.....
Pitkin	8,506	20.46	109,514	11,657	169,925	.....
Rio Grande	8	22.93	16	.....	.....	.....
Saguache	9	4.99	11	.....	79	.....
San Juan	99,529	20,737.29	232,580	415,848	2,215,355	940,836
San Miguel	495,514	102,297.52	1,269,150	322,272	3,937,870	.....
Summit	2,032	2,389.55	14,951	197	44,942	.....
Teller	939,423	580,312.11	89,056	.....	.....	.....
Total	2,157,762	893,819.64	6,584,493	4,395,772	19,150,122	2,948,759

Content of copper ores sold or treated in Colorado in 1914, by counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*
Boulder	13	12.28	184	955	.....
Chaffee	259	1.86	674	21,942	.....
Clear Creek	941	1,098.35	16,811	73,042	28,174
Custer	12	4.75	603	750	786
Dolores	3,502	83.30	23,336	329,801	937
Eagle	7	10.12	235	1,687	33
El Paso	25	.....	.....	2,644	.....
Fremont	682	69.67	1,051	190,652	.....
Gilpin	2,004	666.73	13,515	250,152	544
Hinsdale	65	4.65	1,236	15,953	.....
Lake	4,037	1,210.88	109,774	359,025	51,992
La Plata	239	.25	383	13,729	.....
Montrose	66	.53	510	32,414	.....
Ouray	63	25.72	1,385	6,048	.....
Saguache	51	1.00	1,179	3,090	1,800
San Juan	230	53.79	2,969	28,172	12,664
Total	12,196	3,243.88	173,845	1,330,056	96,930

Content of lead ores sold or treated in Colorado in 1914, by counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*
Boulder	1,792	191.26	116,335	11,185	432,158
Chaffee	7,455	9,143.13	99,139	93,760	1,321,474
Clear Creek	3,159	1,054.25	85,673	31,929	975,775
Custer	108	2.28	1,854	302	4,800
Dolores	1,841	130.53	43,819	8,640	254,293
Eagle	277	8.22	12,614	536	53,514
Fremont	1	.....	6	43	308
Gilpin	821	829.66	19,588	12,530	177,332
Grand	6	.....	1,130	.....	1,198
Gunnison	799	5.00	38,665	153	252,829
Hinsdale	28	1.58	4,273	945	4,906
Lake	46,388	14,303.94	481,334	144,690	10,473,293
Mineral	181	72.94	343	282	25,444
Ouray	1,635	69.66	62,823	6,900	415,772
Park	854	40.04	13,184	2,780	125,234
Pitkin	109,197	.....	262,022	56,080	23,016,165
Saguache	1,149	745.67	12,142	16,176	419,832
San Juan	16,261	3,582.08	247,763	353,086	2,815,318
San Miguel	228	11.54	11,311	1,833	101,859
Summit	907	333.46	18,925	4,362	368,182
Total	193,087	30,525.24	1,532,943	746,212	41,239,726

Content of zinc ores sold or treated in Colorado in 1914, by counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	104	.....	.....	.....	.....	61,597
Clear Creek	7	.41	530	.....	281	4,574
Custer	19	.....	.....	.....	.....	4,470
Eagle	1,023	.....	.....	.....	.....	161,002
Lake	143,848	.90	398	49	11,041	55,680,342
Ouray	14	.93	118	386	1,169	8,084
Park	101	.....	.....	.....	.....	57,940
Pitkin	90	.....	.....	.....	.....	52,194
Summit	450	.....	.....	.....	.....	264,463
Total	145,656	2.24	1,046	435	12,491	56,294,706

Content of copper-lead ores sold or treated in Colorado in 1914, by counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*
Boulder	70	9.60	42,841	7,387	35,512
Chaffee	514	16.63	24,960	44,320	142,168
Clear Creek	1	.74	19	215	762
Gilpin	8	19.13	299	661	1,726
La Plata	1	.03	29	378	102
Ouray	5	.56	1,734	592	907
Park	11	.....	533	2,020	2,145
Saguache	264	46.46	4,887	16,517	108,424
San Juan	318	195.76	6,817	25,582	79,415
Total	1,192	288.91	82,119	97,672	371,161

Content of lead-zinc ores sold or treated in Colorado in 1914, by counties.

	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	304	.....	.....	.....	59,454	150,729
Clear Creek	17,838	139.56	53,452	.....	532,295	1,050,210
Dolores	880	3.20	1,298	.....	205,207	366,549
Eagle	44,837	205.03	14,493	1,258	1,108,156	7,361,096
Gunnison	1,085	9.40	12,943	10,679	57,505	525,000
Lake	81,980	2,318.64	300,107	51,346	10,094,726	23,082,952
Ouray	27	4.39	678	471	3,893	14,962
Pitkin	207	.....	1,350	.....	47,140	93,237
Saguache	15	.70	74	.....	4,737	8,941
San Juan	1,650	28.66	3,788	2,492	76,248	30,341
Summit	18,810	181.55	26,115	2,780	1,152,107	4,847,478
Total	167,633	2,891.13	414,298	69,026	13,341,468	37,531,495

MINING INDUSTRY IN COLORADO IN 1914.

The output of Colorado mines during 1914 was $19,883,105 in gold, 8,796,065 fine ounces of silver, 74,211,898 pounds of lead, 6,639,173 pounds of copper, and 96,774,960 pounds of zinc (in terms of spelter and zinc in zinc oxide), with a total gross value in recovered metals of $33,460,126, as compared with $35,450,585, a decrease in value for 1914 of $1,990,459, or nearly 6 per cent. There was an increase of $1,736,189 in gold, a decrease of 529,190 ounces of silver, a decrease of 13,685,875 pounds of lead, a decrease of 588,653 pounds of copper, and a decrease of 22,571,469 pounds of zinc. The heaviest decrease in value was $1,747,877 for zinc, but there were decreases of $768,230 for silver, of $237,303 for copper, and of $973,238 for lead.

The average prices for metals for the calendar years 1913 and 1914 were:

Average prices of silver, copper, lead, and zinc in 1913 and 1014.

	1913	1914
Silver (fine ounce at New York)	$0.604	$0.553
Copper (pound, electrolytic, at New York)	.155	.133
Lead (pound at New York)	.044	.039
Zinc (spelter, pound at St. Louis)	.056	.051

The Globe, Leadville, Pueblo, Durango, and Salida smelters were operated continuously on ore from British Columbia, Canada, Colorado, Idaho, South Dakota, and other States, including a considerable quantity of zinc residues from Kansas and Oklahoma zinc smelters. The United States Zinc Co.'s zinc smelter, at Pueblo, was operated steadily on zinc-lead ores from various counties in Colorado, and also from Arizona, Idaho, Nevada, and Utah. The copper-matting plant at Ouray was operated steadily during 1914 and construction work on a 200-ton addition to the plant was completed early in 1915. The Western Chemical Co.'s sulphuric acid, magnetic separation, wet-concentration plant,[1] at Denver, was operated steadily, as was the Empire Zinc Co.'s 200-ton magnetic separation plant,[2] at Canon City, both treating chiefly Leadville zinc-lead sulphide ores. The Sutton, Steele & Steele dry concentration and static electric separation plant, at Denver, was operated during the year on various classes of ore from different districts in the State, but was closed in December. Cyanide precipitates and copper ore were shipped to Omaha, and copper ore and copper matte were shipped to Utah plants.

It is worthy of note that froth flotation was introduced successfully at the Atlas mill, Sneffels district, Ouray County; at the Pingrey mill, Leadville, Lake County; at the Silver Lake mill, Animas district, and at the Gold King mill (for the treatment of slimes), Eureka district San Juan County; and that tests leading to its installation were made at the Mary Murphy mill, St. Elmo, Chaffee County.

The following list gives the active smelting plants in Colorado in 1914:

List of active smelting plants in Colorado in 1914.

City.	Plant.	Owner.	Class of ore.	Production.	Total furnaces.[a]
Denver	Globe	American Smelting & Refining Co.	Lead base[b]	Lead bullion and copper matte.	7
Pueblo	Pueblo	do	do	do	7
Leadville	Arkansas Valley	do	do	do	10
Durango	Durango	do	do	do	4
Salida	Salida[c]	Ohio & Colorado Smelting & Refining Co.	do	do	4
Pueblo	United States Zinc Co.	American Smelting & Refining Co.	Zinc - lead - copper-gold-silver.	Spelter and zinc dust.	1,920 retorts.
Ouray	Wanakah	Wanakah Mining Co.	Pyritic copper	Copper matte	1

[a] Not all used.
[b] Copper ores and copper in other ores are handled by occasionally turning a lead furnace into a copper furnace.
[c] Weeks, F. D., The Salida smelter: Am. Inst. Min. Eng. Bull. 104, pp. 1691–1695, 1915.

Cripple Creek produced 60 per cent of the total gold output of the State with a yield of $11,996,116, as compared with $10,905,003 in 1913. This is the largest production for any one year since 1908. Cripple Creek, to the end of 1914, has produced $258,786,653 in gold. The Roosevelt tunnel continued to lower the water level gradually except in the Vindicator and Golden Cycle mines, where electric pumps, installed in 1913, are used. In July, 1914, preparations were

[1] For description, see Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 150–151, 1914.
[2] For description, see Livingston, A. R., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 100–101, 1914.

completed for continuing the tunnel to the Vindicator-Golden Cycle territory—an addition of 10,250 feet—and from August 3 to November 4, when the El Paso plant was destroyed by fire and the work in the tunnel stopped, the heading had been advanced 270 feet. Work was resumed March 2, 1915. The water flow from the tunnel between July 1, 1914, and March 1, 1915, varied from 7,300 to 8,213 gallons a minute. From the collars of the shafts the depth of ground to the tunnel will be 2,100 feet at the Vindicator No. 1, 1,955 feet at the Golden Cycle, 2,145 feet at the Portland No. 2, 1,645 feet at the Elkton, and 2,645 feet at the American Eagles.

The Golden Cycle and the Portland cyanidation mills, at Colorado Springs, were operated steadily, with a considerably increased output. Cyanide mills in the district also made an increased output. The Union cyanidation plant, at Florence, and the U. S. Reduction & Refining Co.'s chlorination and cyanidation plants, at Colorado City, were idle. An attempt was made to cyanide the old dumps of the Metallic Co., at Florence. The output of concentrates and smelting ore from Cripple Creek increased appreciably.

Lake County (chiefly Leadville, but also from the Lackawanna Gulch and St. Kevin districts) produced $1,571,451 in gold, 3,810,830 ounces of silver, 26,784,615 pounds of lead, 2,382,910 pounds of copper, and 78,763,334 pounds of zinc, with a total value of $9,057,297, against $1,023,631 in gold, 3,400,318 ounces of silver, 29,286,183 pounds of lead, 1,923,987 pounds of copper, and 93,842,857 pounds of zinc, with a total value of $9,919,433, in 1913. The output of zinc carbonate was 113,881 tons of 24.3 per cent zinc, as compared with 135,760 tons of 27.45 per cent zinc in 1913. The production of zinc and lead-zinc sulphide smelting and concentrating ore combined increased from 97,704 tons of 23 per cent zinc in 1913 to 111,947 tons of 21.2 per cent zinc in 1914. A 50-ton zinc-oxide plant was built at Leadville for the treatment of zinc carbonate ores of 16 per cent or less, but was operated for only a short period in 1914. The Leadville district mill was remodeled and the mineral separation flotation equipment added, and, after considerable experimental work, the mill was operated on zinc-lead sulphide ores from Leadville and Red Cliff. The unwatering of the downtown mines was assured by the ordering of electric pumps and motors, and surface preparations were begun for installation at the Penrose shaft. Lake County (including Leadville placers and deep mines, placers on Arkansas River and its tributaries included in Lake County, and deep mines of the St. Kevin and Lackawanna Gulch districts) has produced from 1860 to 1914 a total of $359,670,241, divided into $6,165,905 placer gold, $36,640,591 lode gold, 215,212,688 ounces of silver, with a commercial value of $176,628,520; 87,306,361 pounds of copper, with a commercial value of $11,507,838; 1,802,865,683 pounds of lead, with a commercial value of $77,447,227; and 916,510,370 pounds of zinc, with a commercial value of $51,280,160.

The San Juan region of Dolores, La Plata, Ouray, San Juan, and San Miguel counties produced $3,969,857 in gold, 2,515,437 ounces of silver, 11,861,766 pounds of lead, 2,379,639 pounds of copper, and 1,382,334 pounds of zinc, compared with $4,071,683 in gold, 2,769,077 ounces of silver, 21,740,502 pounds of lead, 3,373,935 pounds of copper, and 6,867,410 pounds of zinc in 1913. There was an increase in gold of $252,616 in Ouray County, but decreases of $186,393 in La Plata,

of $149,135 in San Juan, of $14,455 in San Miguel, and of $4,459 in Dolores. There were increases in silver of 229,365 ounces in San Miguel and 56,655 ounces in Ouray, but decreases of 386,492 ounces in San Juan, 92,290 ounces in Dolores, and 60,878 ounces in La Plata. Dolores, San Miguel, and San Juan counties all showed heavy decreases in lead, copper, and zinc. The Tomboy Co. produced no zinc concentrate, as the Montana vein contains little or no zinc. Ouray County, because of increased production at the Camp Bird, the steady production of the Wanakah mill and copper matting plant, and the successful application of flotation to the Atlas ores, showed appreciable increases in gold, silver, and copper, and a small decrease in lead.

Boulder County's production was $98,710 in gold, 312,217 ounces of silver, 523,821 pounds of lead, and 24,316 pounds of copper—an increase of $29,436 in gold, 149,833 ounces of silver, and 114,321 pounds of lead.

Chaffee County produced $332,230 in gold, 272,242 ounces of silver, 3,690,359 pounds of lead, 319,496 pounds of copper, and 2,173,177 pounds of zinc, a considerable increase for all the metals except copper, which about equaled the yield in 1913.

Clear Creek County's output was $495,275 in gold, 345,387 ounces of silver, 2,435,692 pounds of lead, 367,790 pounds of copper, and 1,067,314 pounds of zinc, an increase of $62,786 in gold, but decreases in the other metals. A considerable quantity of Gilpin County ores was treated in Clear Creek County mills or sold to the sampler at Idaho Springs, and the contents of this ore have been credited to Gilpin County.

Gilpin County's output was $573,553 in gold, 145,237 ounces of silver, 499,718 pounds of lead, and 726,579 pounds of copper, including ore mined through the Newhouse tunnel.

Idaho Springs district, Clear Creek County, produced $386,512 in gold, 193,221 ounces of silver, 1,239,572 pounds of lead, 250,744 pounds of copper, and 12,530 pounds of zinc in 1914, as compared with $282,603 in gold, 214,481 ounces of silver, 1,628,324 pounds of lead, 309,885 pounds of copper, and 4,639 pounds of zinc in 1913. Idaho Springs district, Clear Creek County, and the southern districts of Gilpin County combined produced $950,001 in gold, 333,241 ounces of silver, 1,704,236 pounds of lead, 976,174 pounds of copper, and 25,510 pounds of zinc, as compared with $958,618 in gold, 487,312 ounces of silver, 2,836,029 pounds of lead, 1,143,040 pounds of copper, and 13,108 pounds of zinc in 1913.

The Pitkin County (Aspen) yield was 372,886 ounces of silver and 23,233,230 pounds of lead—a decrease of 189,422 ounces of silver but an increase of 5,704,844 pounds of lead. But for the fire in the Smuggler workings the output would have been larger.

Creede (Mineral County) produced $19,304 in gold, 615,734 ounces of silver, 1,401,795 pounds of lead, and 32,586 pounds of copper, but no zinc—an appreciable decrease for all metals other than copper.

Gunnison County's output, from deep and placer mines, was $13,033 in gold, 59,036 ounces of silver, 317,974 pounds of lead, 11,188 pounds of copper, and 525,000 pounds of zinc—an increase for gold, lead, and zinc, but a decrease for silver and copper. Hinsdale County's output was nominal.

The output of placer gold from dredges and other placer operations at Breckenridge, Summit County, was $608,567, as compared with $386,196 in 1913, and the yield of considerable high-grade ore from pocket mines at Breckenridge and the gold in smelting ore and concentrates from Kokomo, Breckenridge, and Montezuma, gave a total yield of gold for the county of $668,610, as against $462,228 in 1913. The silver yield in 1914 was 67,009 ounces; lead, 1,565,231 pounds; copper, 7,339 pounds; and zinc, 5,111,941 pounds.

Eagle County's output came chiefly from Red Cliff, but included a small quantity of silver ore from the Lady Belle and North Dakota mines, in the Bush Creek district. The total yield was $47,194 in gold, 127,080 ounces of silver, 1,177,385 pounds of lead, 28,105 pounds of copper, and 7,522,098 pounds of zinc—a small increase in gold, decreases in silver, lead, and copper, and 838,455 pounds increase for zinc.

The Park County output of gold increased from both placers and deep mines, but the yield of the other metals decreased.

The number of mines producing metals in 1914 was 866, of which 35 were placers, as against 858 mines, of which 29 were placers, in 1913.

In 1914 there were sold or treated 2,677,526 short tons (mostly dry weight) of ore mined in Colorado, a decrease of 57,340 tons from the output of 1913. Of this total, 1,630,640 short tons (mostly dry weight) went to gold and silver mills, 378,743 tons (mostly dry weight) went to mills for concentration only, and 668,143 dry tons went crude to smelters; 188,770 dry tons of concentrates also went to smelters.

From the mine standpoint, 114,860 dry tons of zinc carbonate ore averaging 24.34 per cent zinc were sold in 1914, as compared with 137,240 tons of 27.5 per cent zinc in 1913, and 136,705 tons of crude zinc and zinc-lead ore, concentrates, and middlings, averaging 25 per cent, were sold at the mines during 1914, as compared with 134,457 tons of 27 per cent in 1913.

The following table shows the production of gold, silver, copper, lead, and zinc in Colorado, by counties:

Mine production of gold, silver, copper, lead, and zinc in 1914 in Colorado, by counties.

County.	Producing mines.	Ore sold or treated.	Gold.		Silver.	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ozs.*		*Fine ozs.*	
Boulder	147	14,591	4,775.10	$98,710	312,217	$172,656
Chaffee	19	61,698	16,071.63	332,230	272,242	150,550
Clear Creek	101	101,366	23,958.93	495,275	345,387	190,999
Costilla	1	.....	8.56	177	2	1
Custer	14	870	162.78	3,365	15,975	8,834
Dolores	10	6,905	385.70	7,973	86,526	47,849
Douglas	3	.....	6.77	140	.....	.....
Eagle	24	49,377	2,283.01	47,194	127,080	70,275
El Paso	1	25	.....	.....	.....	.....
Fremont	2	706	71.40	1,476	1,066	589
Garfield	1	73	116.25	2,403	80	44
Gilpin	123	52,839	27,745.63	573,553	145,237	80,316
Grand	1	10	.15	3	1,747	966
Gunnison	12	6,018	630.47	13,033	59,036	32,647
Hinsdale	7	118	8.22	170	5,987	3,311
Lake	96	547,463	76,018.94	1,571,451	3,810,830	2,107,389
La Plata	27	5,083	6,119.34	126,498	60,244	33,315
Mineral	9	27,952	933.83	19,304	615,734	340,501
Moffatt	4	.....	214.59	4,436	11	6
Montrose	3	66	21.57	446	517	286
Ouray	37	105,560	58,630.16	1,211,993	594,289	328,642
Park	15	1,958	3,264.59	67,485	20,215	11,179
Pitkin	13	118,000	20.46	423	372,886	206,206
Rio Grande	1	8	22.93	474	16	9
Routt	2	.....	12.63	261	5	3
Saguache	8	1,488	798.82	16,513	18,293	10,116
San Juan	29	117,988	24,597.58	508,477	493,917	273,136
San Miguel	25	495,742	102,309.06	2,114,916	1,280,461	708,095
Summit	51	22,199	32,343.99	668,610	67,009	37,056
Teller	80	939,423	580,312.11	11,996,116	89,056	49,248
Total, 1914	866	2,677,526	961,845.20	19,883,105	8,796,065	4,864,224
Total, 1913	858	2,734,866	877,857.06	18,146,916	9,325,255	5,632,454
Increase (+) or decrease (−)	+8	−54,340	+83,988.14	+1,736,189	−529,190	−768,230

County.	Copper.		Lead.		Zinc.		Total value
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Boulder	24,316	$3,234	523,821	$20,429	.....	.....	$295,029
Chaffee	319,496	42,493	3,690,359	143,924	2,173,177	$110,832	780,029
Clear Creek	367,790	48,916	2,435,692	94,992	1,067,314	54,433	884,615
Costilla	.....	.....	.....	.....	.....	.....	178
Custer	3,481	463	9,692	378	4,470	228	13,268
Dolores	350,278	46,587	492,023	19,189	366,549	18,694	140,292
Douglas	.....	.....	.....	.....	.....	.....	140
Eagle	28,105	3,738	1,177,385	45,918	7,522,098	383,627	550,752
El Paso	2,644	352	.....	.....	.....	.....	352
Fremont	191,917	25,525	308	12	.....	.....	27,602
Garfield	128	17	.....	.....	.....	.....	2,464
Gilpin	726,579	96,635	499,718	19,489	12,980	662	770,655
Grand	.....	.....	1,563	61	.....	.....	1,030
Gunnison	11,188	1,488	317,974	12,401	525,000	26,775	86,344
Hinsdale	17,098	2,274	5,723	223	.....	.....	5,978
Lake	2,382,910	316,927	26,784,615	1,044,600	78,763,334	4,016,930	9,057,297
La Plata	26,038	3,463	11,410	445	.....	.....	163,721
Mineral	32,586	4,334	1,401,795	54,670	.....	.....	418,809
Moffat	.....	.....	.....	.....	.....	.....	4,442
Montrose	32,414	4,311	.....	.....	.....	.....	5,043
Ouray	854,038	113,587	2,119,564	82,663	44,608	2,275	1,739,160
Park	8,023	1,067	168,154	6,558	57,940	2,955	89,244
Pitkin	67,737	9,009	23,233,230	906,096	145,431	7,417	1,129,151
Rio Grande	.....	.....	.....	.....	.....	.....	483
Routt	.....	.....	.....	.....	.....	.....	264
Saguache	35,783	4,759	534,872	20,860	8,941	456	52,704
San Juan	825,180	109,749	5,199,000	202,761	971,177	49,530	1,143,653
San Miguel	324,105	43,106	4,039,769	157,551	.....	.....	3,023,668
Summit	7,339	976	1,565,231	61,044	5,111,941	260,709	1,028,395
Teller	.....	.....	.....	.....	.....	.....	12,045,364
Total, 1914	6,639,173	883,010	74,211,898	2,894,264	96,774,960	4,935,523	33,460,126
Total, 1913	7,227,826	1,120,313	87,897,773	3,867,502	119,346,429	6,683,400	35,450,585
Increase (+) or decrease (−)	−588,653	−237,103	−13,685,875	−973,238	−22,571,469	−1,747,877	−1,990,459

REDUCTION MILLS IN COLORADO.

Mineral Resources for 1912, Part I, pages 650–664, 1913, contains a complete list of the reduction mills in Colorado in 1912, with description of equipment and process. Changes in this list for 1914 have been noted in the text of the various counties, and reference should be made to the 1912 report for details of equipment.

Ore to gold and silver mills and concentrating mills, with quantity of gold and silver contained in bullion produced in Colorado in 1914, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Boulder	7,160	787.65	315	102
Chaffee	49,664	298.44	173	.....
Clear Creek	42,593	3,106.10	5,854	44,479
Custer	300	59.80	459	19
Dolores	.....	14.71	2	407
Eagle	.....	.....	.....	45,676
Gilpin	27,749	4,010.39	3,454	15,466
Gunnison	4,000	242.03	192	439
Lake	11,080	6,019.02	1,603	63,670
La Plata	.....	119.92	24	.....
Ouray	48,991	28,407.34	8,813	32,033
Park	200	33.46	5	.....
Pitkin	.....	20.46	153	79,475
San Juan	55,700	6,053.24	2,629	57,613
San Miguel	476,240	68,717.64	598,193	19,091
Summit	.....	1,834.72	876	20,273
Teller	906,963	492,418.66	53,486	.....
Total, 1914	1,630,640	612,143.58	676,231	378,743
Total, 1913	1,610,335	554,722.35	443,444	459,533
Increase (+) or decrease (−)	+20,305	+57,421.23	+232,787	−80,790
Average content per ton	.....	0.3754	0.4147	.....

Mine production of gold, silver, copper, lead, and zinc from Colorado concentrates in 1914, by counties.

County.	Concentrates.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	286	512.37	20,431	2,547	48,512	.....
Chaffee	5,970	5,131.08	42,791	153,108	2,077,639	1,960,851
Clear Creek	11,336	9,589.05	149,557	145,430	1,163,678	1,052,303
Custer	7	.....	.....	.....	.....	4,470
Dolores	278	3.20	1,298	.....	96,115	148,371
Eagle	11,737	205.03	14,271	1,258	1,106,086	7,427,029
Gilpin	6,870	8,944.55	44,680	203,767	181,700	12,980
Gunnison	354	76.43	4,615	10,624	38,654	179,500
Lake	54,908	2,847.89	256,800	51,434	7,032,368	14,792,668
Ouray	12,496	20,691.64	414,251	316,862	1,752,808	36,524
Pitkin	25,720	.....	115,933	40,177	13,025,966	.....
San Juan	16,337	15,362.58	292,983	665,404	3,949,973	971,177
San Miguel	26,576	33,474.21	668,777	321,657	3,934,168	.....
Summit	7,748	175.98	27,503	2,529	1,175,663	4,834,043
Teller	8,147	19,249.05	4,662	.....	.....	.....
Total, 1914	188,770	116,263.06	2,058,557	1,914,797	35,583,330	1,419,916
Total, 1913	218,291	123,177.64	2,320,781	2,366,458	47,027,901	41,692,027
Decrease (−)	−29,251	−6,914.58	−262,224	−451,661	−11,444,571	−10,272,111
Subdivision by kinds of concentrates:						
Dry and siliceous	43,329	70,713.89	606,720	775,459	1,712,625	.....
Copper	85	73.44	910	13,678	.....	.....
Lead	94,608	39,838.38	1,190,924	679,350	30,199,482	.....
Zinc	42,056	385.82	77,876	31,309	806,559	29,197,205
Copper-lead	5,609	4,408.95	164,615	376,904	2,562,468	.....
Lead-zinc	3,083	842.58	17,512	38,097	302,196	2,222,711
Average content:		*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry and siliceous	.....	1.632	14.003	0.902	1.988	.....
Copper	.....	.864	10.705	8.045	.....	.....
Lead	.....	.421	12.587	.359	15.96	.....
Zinc	.....	.009	1.850	.037	.958	[a] 41.78
Copper-lead	.....	.786	29.35	3.36	22.842	.....
Lead-zinc	.....	.273	5.68	.62	4.90	[a] 43.66

[a] Crude assay; no deduction for loss in smelting.

Mine production of gold, silver, copper, lead, and zinc from Colorado crude ore shipped to smelters in 1914, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	7,329	3,475.08	291,471	21,769	475,309	.....
Chaffee	12,034	10,611.82	229,271	166,388	1,612,720	212,326
Clear Creek	14,294	11,263.78	189,976	222,360	1,272,014	15,011
Custer	551	102.98	15,516	3,481	9,692	.....
Dolores	6,498	367.79	852,226	350,278	395,908	218,178
Eagle	3,701	2,077.98	112,809	26,847	71,299	95,069
El Paso	25	.....	.....	2,643	.....	.....
Fremont	706	71.40	1,066	191,917	308	.....
Garfield	73	116.25	80	128	.....	.....
Gilpin	9,624	14,790.69	97,103	522,812	318,018	.....
Grand	10	.15	1,747	.....	1,563	.....
Gunnison	1,579	99.94	54,164	564	279,320	345,500
Hinsdale	118	8.22	5,987	17,099	5,723	.....
Lake	472,713	67,152.03	3,552,427	2,331,476	19,752,247	63,970,666
La Plata	5,083	5,999.42	60,220	26,038	11,410	.....
Mineral	27,952	933.83	615,734	32,586	1,401,795	.....
Montrose	66	.53	510	32,414	.....	.....
Ouray	24,536	9,531.18	171,225	537,176	366,756	8,084
Park	1,758	2,102.35	20,004	8,023	168,154	57,940
Pitkin	38,525	.....	256,800	27,560	10,207,264	145,431
Rio Grande	8	22.93	16	.....	.....	.....
Saguache	1,488	798.82	18,293	35,783	534,872	8,941
San Juan	4,675	3,181.76	198,300	159,776	1,249,027	.....
San Miguel	411	117.21	13,491	2,448	105,601	.....
Summit	1,926	893.86	31,612	4,810	389,568	277,898
Teller	32,460	68,644.40	30,908	.....	.....	.....
Total, 1914	668,143	202,364.40	6,053,956	4,724,376	38,628,568	65,355,044
Total, 1913	664,998	180,193.95	6,556,467	4,861,368	40,869,872	77,654,402
Increase (+) or decrease (−)	+3,145	+22,170.44	−502,511	−136,992	−2,241,304	−12,299,358
Subdivision by kinds of ore:						
Dry and siliceous	390,885	170,942.64	4,438,875	2,858,788	8,424,498	.....
Copper	12,196	3,243.88	173,845	1,330,056	96,930	.....
Lead	99,105	27,802.24	1,299,586	436,027	26,400,868	.....
Zinc	144,737	2.24	1,046	435	12,491	56,212,636
Copper-lead	1,192	288.91	82,119	97,672	371,161	.....
Lead-zinc	20,028	84.49	58,485	1,398	3,322,620	9,142,408
Average content:		*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry and siliceous	.....	0.437	11.355	0.365	1.077	.....
Copper	.....	.267	14.25	5.407	.397	.....
Lead	.....	.281	13.11	.219	13.318	.....
Zinc	.....	.....	.....	.....	.....	[a] 23.10
Copper-lead	.....	.242	68.891	4.096	15.568	.....
Lead-zinc	.....	.004	2.910	.003	8.295	[a] 28.30

[a] Crude-assay; no deduction for loss in smelting.

Output of ore, concentrates, and tailings to amalgamation, cyanidation, and chlorination mills, with quantity of gold and silver contained in bullion and precipitates in Colordoa, in 1914, by processes.

Process.	Quantity.	Gold in bullion.	Silver in bullion.
	Short tons.	*Fine ounces.*	*Fine ounces.*
Chlorination	.....	7,668.55	20
Amalgamation	[a] 593,409	87,231.98	52,295
Cyanidation	[b] 1,263,867	517,243.05	623,916
Total	.....	612,143.58	676,231

[a] Represents crude ore; amalgamation in many cases followed by concentration and cyanidation.
[b] Represents crude ore, concentrates, old tailings, and tailings of ore first treated by amalgamation and concentration.

Consumption of quicksilver and cyanide in Colorado mills in 1914.

Quicksilver.	Potassium cyanide.	Sodium cyanide.
Pounds.	*Pounds.*	*Pounds.*
[a] 6,059	[b] 35,800	[b] 935,589

[a] Represents 1 pound of mercury for every 98 tons of ore and 1 pound of mercury for every 14.40 ounces of gold and 8.63 ounces of silver.

[b] Potassium and sodium cyanide combined were used at the ratio of 0.77 pound of cyanide per ton of ore or tailings treated and for every pound used there were recovered 0.53 ounce gold and 0.70 ounce silver.

REVIEW BY COUNTIES.

BOULDER COUNTY.

Mine production of gold, silver, copper, and lead in Boulder County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	121	5,719	$69,274	162,384	25,535	409,500	$189,330
1914	147	14,591	98,710	312,217	24,316	523,821	295,029
Increase (+) or decrease (−)	+26	+8,872	+29,436	+149,833	−1,219	+114,321	+105,699

Boulder County in 1914 produced 14,591 tons of ore, yielding $98,710 in gold; silver, valued at $172,656; copper, at $3,234; lead, at $20,429—a total value of $295,029 and an increase for 1914 of $105,699. Despite an increase of $29,436 in gold, the increase in silver of 149,833 ounces in quantity and $74,576 in value continued to make silver the most important metal produced in the county, whereas up to 1912 gold had long been the predominant metal. The lead yield also again increased appreciably.

The output of milling ore increased heavily, as did the quantity of concentrates and the contents thereof. The yield of small high-grade lots from pockets, which have always contributed considerable gold, decreased somewhat, but the total bullion produced from all sources increased appreciably. The output of smelting ore increased from 4,614 tons to 7,329 tons and the contents of smelting ore showed an increase of 765.03 fine ounces gold, 129,450 ounces of silver, and 65,981 pounds of lead.

Central district.—The production of Central district (near Jamestown) was 324 tons of ore, carrying $5,826 in gold, 7,029 ounces of silver, 5,306 pounds of copper, and 139,157 pounds of lead, with a total value of $15,846, as compared with $21,180 in 1913. With the exception of approximately $120 in gold from small lots of high-grade gold ore to a small custom chlorination plant at Boulder, all the ore went to smelters. The principal producing mines were the Alice, Argo, Chancellor, Earl, Little Ethel, Smuggler, and Tippecanoe.

Gold Hill district.—Once the principal producing district in Boulder County, the Gold Hill district fell in 1914 to fourth place, below Sugar Loaf, Ward, and Grand Island districts, with an output of

1,822 tons of ore, yielding $26,025 in gold, 4,379 ounces of silver, and 6,240 pounds of lead, with a total value of $28,690, as compared with $36,027 in 1913. Mill bullion contained about one-third of the gold, and crude ore and concentrates the remainder of the metals produced in the district.

The Black Cloud 20-stamp mill was overhauled, and 10 stamps and concentrating equipment were put in operation as a custom plant during the latter part of the year. The Gold Nugget 25-stamp amalgamation mill was operated from July to October.

The principal producing mines were the Addison, Big Horn, Black Cloud, Cash, Clarence, Gold Nugget, Gold Standard, Grey Eagle, Hoodoo, Ingram, Kenilworth, Little Johnny, Nil Desperandum, Prussian, Richmond, Scotia, Slide, Triune, and Western Slope.

Grand Island district (Cardinal, Caribou, Eldora, Nederland).—This district, long dormant, ranked third in output in the county in 1914, and produced 6,987 tons of ore, carrying $22,680 in gold, 26,791 ounces of silver, 4,703 pounds of copper, and 66,924 pounds of lead, with a total value of $40,730.

The Boulder County mine (opened by an adit 3,200 feet long) was reopened early in the year and the 35-ton amalgamating and concentrating mill was operated from July through December by the Cariman Co. The old Caribou group, including the Caribou, Poorman, and No Name mines, was also taken over by the Cariman Co. and will be operated in conjunction with the Boulder County mine. To unwater the Caribou group it is proposed to drive a crosscut 7,000 feet long from the Boulder County adit. At the Caribou mine a new 100-ton cyanide plant[1] was nearly completed in 1914. An appreciable tonnage of gold-silver ore was shipped from the Mogul tunnel and small lots from the Little Belle and the Fourth of July mines at Eldora and from the St. Louis mine at Caribou. From the Up-To-Date mine, at Caribou, copper and copper-lead ore, carrying gold and silver, was shipped in small lots to the smelter and a quantity of the milling ore was sent to the Boulder County mill to test the results of concentration of this ore.

Magnolia district.—The Magnolia district in 1914 yielded $10,551 in gold, 221 ounces of silver, and 83 pounds of copper, with a total value of $10,684, as against $7,686 in 1913. Several small lots of high-grade ore were treated by chlorination at Boulder, and the rest went to the smelter. The principal producing mines were the American, Cash, Gold Farm, Graphic, Hereafter, Kekionga, Magnolia, Ophir, Sac and Fox, and Senator Hill.

Sugar Loaf district.—This district was again the principal producing district in the county in 1914, with an output of 3,018 tons of ore, yielding $25,892 in gold, 195,902 ounces of silver, 12,128 pounds of copper, and 69,272 pounds of lead, with a total value of $138,541, as compared with $74,957 in 1913. The bulk of the ore was shipped to smelters. The free-milling ore of the Logan mine was treated in a small laboratory plant or sold to a custom plant at Boulder; in addition, a good grade of smelting ore was shipped. Considerable silver-gold ore was shipped from the Forest mine and a large output of lead-silver ore was shipped from the Yellow Pine mine. The other principal producing mines were the Alpine, Copper Glance, Doss, Lord Byron, Nancy, and Wisconsin. A "clean-up" of material

[1] For description and flow sheet see Parmelee, H. C., Metall. and Chem. Eng., August, 1915.

around the idle Wood Mountain mill was made. Development work was done on the property of the United States Gold Corporation, and a Herreshoff roaster was added to the equipment of the cyanidation mill.

Ward district.—The Ward district in 1914 produced 2,068 tons of ore, yielding $7,736 in gold, 77,895 ounces of silver, 2,096 pounds of copper, and 242,228 pounds of lead, with a total value of $60,538, as against $45,808 in 1913. All the ore was shipped to smelters, with the exception of shipments from the Columbia and Dew Drop mines, treated at the Black Cloud amalgamation and concentration mill at Gold Hill; of lessees' operations in concentrating the dump of the B. and M. mine; of a small shipment from the Nelson mine to the Portland mill at Colorado Springs; and of small lots of bullion from various properties. The White Raven mine was the principal producing mine, the shipments being lead-silver ore. Other producing mines were the Black Jack, Grand View, Humboldt, Inspruck, Morning Star, and New Market.

CHAFFEE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Chaffee County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	18	49,135	$312,892	168,985	315,011	3,196,545	2,121,947	$723,263
1914	19	61,698	332,230	272,242	319,496	3,690,359	2,173,177	780,029
Increase (+)	+1	+12,563	+19,338	+103,257	+4,485	+493,814	+51,230	+56,766

[a] Includes placer production.

Deep mines in Chaffee County in 1914 produced 61,698 tons of ore, yielding $331,604 in gold; 272,235 ounces of silver, valued at $150,546; 319,496 pounds of copper, valued at $42,493; 3,690,359 pounds of lead, valued at $143,924; and 2,173,177 pounds of zinc, valued at $110,832, a total value of $779,399, as compared with $721,988 in 1913. Placer mines in 1914 yielded $626 in gold and 7 ounces of silver, as compared with $1,266 in gold and 15 ounces of silver in 1913.

There were 15 productive deep mines and 4 placers. The Chalk Creek district continued to produce the greater part of the output of this county.

Chalk Creek district.—The principal mine in the county is the Mary Murphy. The ore minerals of the Mary Murphy, arranged in order of quantity, are zinc blende, galena, pyrite, and chalcopyrite, with cerusite, anglesite, and a little malachite and native sulphur in the oxidized zone; the depth of the zone from the surface is irregular, and varies with different veins. The gangue, in the upper levels, consists of rhodonite and quartz, with a little calcite. In the lower levels it consists mainly of quartz and clay, with calcite and a little fluorite. Gold occurs both in the ore and in the gangue minerals,

but decreases in quantity and becomes strikingly irregular in distribution in the deeper workings. Silver ore also occurs both in the ore and in the gangue minerals and lessens in quantity with depth to a greater degree than the gold.

A large quantity of lead ore was shipped direct to smelters under operation both by the company and by lessees. The greater part of the ore, however, was treated in the company's mill [1] (built in 1912), a wet-concentration plant, with subsidiary amalgamation and electrostatic separation of zinc, iron, and copper. Bullion and lead, iron-copper, and zinc concentrates are the product of the mill. Dry ore, carrying gold, silver, copper, and lead, was shipped from the Iron Chest mine.

Four Mile district.—A small yield of placer gold was made from the Derillo placer on Arkansas River, near Four Mile Creek.

Granite district.—The ancient river bed placer ground on Cache Creek (of the Twin Lakes Placer Co., which prior to 1911 was an important producer of placer gold by hydraulicking but was enjoined in 1911 from polluting the water of Arkansas River), was sluiced, in a small way by various operators. A small shipment of lead ore, carrying gold and silver, was made from the Margaret mine.

Monarch district.[2]—From 8 mines 4,502 tons were shipped, yielding $27,631 in gold, 125,371 ounces of silver, 72,276 pounds of copper, 311,796 pounds of lead, and 212,326 pounds of zinc, with a total value of $129,563, as compared with $52,186 in 1913.

The Madonna mine was again the chief producer [3], with increased shipments of gold-silver-copper-lead ore and some zinc and lead-zinc carbonate ores. The group of 8 mines of which the Madonna is one, is operated through a 1,500-foot adit and a shaft, down 239 feet, of which 100 feet was sunk in 1914. The ore is chiefly oxidized, changing to sulphide at the 239-foot level below No. 6 tunnel. Lead carbonate ore was shipped by lessees from the Alaska mine, part of a group of 17 claims, including the Garfield,[4] under the management of the Eureka M. & R. Co. Lead ore was shipped from the Flossie D., copper-lead ore (mostly oxidized but some sulphide) from the New York, lead-zinc carbonate from the Silent Friend and Wilson, and copper oxidized ore from the Lilly.[4] The Lilly mine is opened by adits aggregating 3,525 feet and a vertical shaft of 368 feet. Oxidation extends to a depth of about 1,000 feet. The Standard Gold-Copper Co., operating the Sunlight mine and 10-stamp amalgamation and concentration mill, made a trial run of the mill and shipped a small quantity of bullion and concentrates.

Riverside district.—Two small shipments of gold-silver-copper-lead ore were made in 1914.

Turret district (including Sedalia).—A small shipment of gold-silver-copper ore was made from the Sedalia mine. The Brown's Canon bench gravel placer was operated for a short time with a rocker.

[1] For description and flow sheet see Parmelee, H. C., Concentration of complex sulphide ore from the Mary Murphy mine: Metall. and Chem. Eng., Jan., 1914, pp. 21–26. See also Collins, G. E., Colorado Bur. Mines Thirteenth Bien. Rept., 1913–14, pp. 65–71, 1914.

[2] For discussion of the geology of the district see Crawford, R. D., Geology and ore deposits of the Monarch and Tomichi districts, Colo.: Colorado State Geol. Survey Bull. 4, 1913.

[3] For the total output of mine, including 1911, see Crawford, R. D., idem, p. 239.

[4] Crawford, R. D., idem, p. 262.

CLEAR CREEK COUNTY.[1]

Mine production of gold, silver, copper, lead, and zinc in Clear Creek County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	105	104,892	$432,489	408,527	426,393	3,999,614	1,489,518	$1,004,726
1914	101	101,366	495,275	345,387	367,790	2,435,692	1,067,314	884,615
Increase (+) or decrease (−)	−4	−3,526	+62,786	−63,140	−58,603	−1,563,922	−422,204	−120,111

[1] For discussion of geology see Spurr, J. E., and Garrey, G. H., Preliminary report on the ore deposits of the Georgetown mining district, Colorado: U. S. Geol. Survey Bull. 260, pp. 99–120, 1905; the Idaho Springs mining district, Colorado: U. S. Geol. Survey Bull. 285, pp. 35–40, 1906; Economic geology of the Georgetown quadrangle (together with the Empire district), Colorado, with general geology by S. H. Ball: U. S. Geol. Survey Prof. Paper 63, 422 pp., 1906.

The total yield of Clear Creek County in 1914 was $495,275 in gold; silver, valued at $190,999; copper, $48,916; lead, $94,992; zinc, $54,433—a total value of $884,615.

The output from the lower Clear Creek mines (Idaho Springs, Cascade, Jackson, Montana, and Trail districts combined) showed an increase in ore treated, an increase in gold and lead, a decrease in silver, copper, and zinc, but an increase in combined values; but the upper Clear Creek mines (Argentine, Empire, and Griffith districts) showed a decrease in quantity of ore and of all the metals.

There were 101 producing deep mines or groups of mines, as compared with 105 in 1913. The quantity of ore sold or treated was 101,366 short tons, as compared with 104,892 tons in 1913.

Alice (or Yankee) district.—The output of the Alice district was $890, mostly gold, as compared with $1,884 in 1913. A small quantity of ore from the Clara mine was treated at the Clara 5-stamp amalgamation-concentration mill, and a small shipment was made to the sampler. A small output from the Puritan and from Reynolds Brothers mine was milled at the Reynolds mill.

Argentine district.—The Argentine district, from 6 mines, produced 3,709 tons, yielding $22,759 in gold, 43,714 ounces of silver, 68,112 pounds of copper, 393,633 pounds of lead, and 148,157 pounds of zinc, with a total value of $78,900, as compared with $79,228 in 1913.

Lead ore from the Josephine mine was sent to concentrating plants and to smelters. A considerable quantity of copper ore was shipped from the Santiago mine. Ore from the Mary Etta mine was sent to smelter or concentrated into lead, zinc, and lead-zinc concentrates. Lead-silver and copper-lead-silver ores were shipped from the Waldorf and the Paymaster mines. Some ore from the Waldorf mine was concentrated into lead-silver concentrates.

Empire (or Upper Union) district (including Daily district).—The Empire district in 1914, from 11 mines, produced 1,626 tons, yielding $13,087 in gold, 21,025 ounces of silver, 6,354 pounds of copper, and 64,215 pounds of lead, with a total value of $28,063, as compared with $28,695 in 1913. As usual, the bulk of the ore from this district was treated by amalgamation and concentration, only 346 tons, or 20 per cent, being sent to smelters. Bullion produced amounted to only

13 per cent of the gold output, and concentrates and smelting ore carried 87 per cent of the gold, nearly all the silver, and all the lead and copper produced in the district.

Considerable ore from the Pioneer mine was treated by amalgamation and concentration. Smelting and concentrating ore was shipped from the General Harrison mine. Gold ore from the Gold Dirt and Gold Fissure mines was concentrated in the district; small shipments were also made to smelter. Lead ore was shipped from the Bellevue-Hudson and Animosa mines. Two small shipments of gold-silver-lead ore were made from the Dr. Towne mine, in the Daily district.

Georgetown (Griffith, Silver Plume) district.—The Georgetown district in 1914, from 14 mines, produced 28,818 tons of ore, yielding $36,988 in gold, 65,477 ounces of silver, 21,310 pounds of copper, 548,939 pounds of lead, and 882,509 pounds of zinc, with a total value of $142,448, as compared with $267,232 in 1913. The output of ore in 1914 was 10,057 tons less than in 1913. The gold production decreased $17,233, and the yield of all the other metals also decreased. Zinc production from this district represented 83 per cent of the county yield.

The Ætna mine, operated by the Capital Co., was the principal mine in the district. It is opened by two adits, 1,700 and 3,300 feet long. The 250-ton amalgamation-concentration mill was operated the entire year on company ore and also on ore from the Ruler mine. Lead and lead-zinc ore and concentrates were shipped by the Coldstream Co. Lead sulphide ore was shipped to smelters and lead-zinc ore was sent to the Graham mill from the Smuggler mine. Lead-zinc ore from the Mendota-Frostburg mine was treated at the Mendota concentration mill, the product being lead concentrates, zinc concentrates, and a zinc-iron middling. Lead and zinc concentrates were produced at the Scotia mill. Lead-zinc ore from the Terrible-Dunderberg mine was concentrated. Small lots of smelting ore were shipped from various other properties.

Idaho Springs district.—In the Idaho Springs district are included the mines about Idaho Springs, including Banner, Cascade, Coral, Jackson, Lower Fall River, Payne's Bar, Spanish Bar, and Virginia subdistricts.

In 1914 there were 62,587 tons of ore mined in the Idaho Springs district, as compared with 53,419 tons in 1913. The production of metals in 1914 was $386,512 in gold, 193,221 ounces of silver, 250,744 pounds of copper, 1,239,572 pounds of lead, and 12,530 pounds of zinc, with a total value for the five metals of $575,694, as compared with $532,088 in 1913.

In 1914, of the 62,587 tons of ore mined, 27,831 tons were treated at amalgamation, cyanidation, and concentration mills, and 24,226 tons were treated at mills for concentration only, a total to both classes of mills of 52,057 tons, yielding 7,269 tons of concentrates (ratio 7 to 1). These concentrates and 10,530 tons of crude ore, 17,799 tons in all, were shipped to smelters and contained all the metals produced by the mines in this district (with the exception of 2,396.95 ounces of gold, valued at $49,550, and 5,482 ounces of silver, valued at $3,032, in amalgamation bullion and cyanide precipitates).

Through the Big Five tunnel ore from the Belman, Edgar, Lake, and Shafter mines was shipped to smelters or to various amalgamation and concentration mills. Ore from the upper levels of the Specie

Payment mine was sent to the Black Hawk sampler, but the bulk of the ore was taken out through the Two Brothers tunnel and sent to custom mills or to the sampler at Idaho Springs. In Virginia Canyon, the Bald Eagle, Calvin, Champion-Trio, Crystal, Papoose, Sunshine, Treasure Vault, Victor, and Windsor Castle mines were producers. Through the Argo (Newhouse) tunnel the principal producing property was the Gem Consolidated Mines, from which a heavy but decreased output of ore was sent to mills and smelters. An increased quantity of ore was mined from the Golden Edge mine, shipments being made to smelters and to various mills. On the Argo tunnel level, 800 feet of lateral was driven west on the Seaton vein, from which some ore was taken out. This mine is also opened through the Foxhall tunnel. Shipments from the Sun and Moon property were resumed in 1914. A considerable output of ore from mines in Gilpin County—the Tremont (formerly Gunnell), Pozo-Dyke, and Kansas mines—was trammed through the Argo tunnel and sold or treated at Idaho Springs. The tonnage and recovered metals from this ore are accredited to Gilpin County. At the mouth of the Argo tunnel, the Argo [1] 20-stamp cyanidation-concentration mill was operated continuously. Ore from the Franklin mine, in Gilson gulch, was shipped to the sampler. Ore from the Idaho-Bride mine (worked through the Idaho tunnel) was milled at the Gem mill, the product being lead and lead-zinc concentrates, and crude lead ore was sent to the sampler. On the south of Clear Creek the Little Mattie mine and mill was an important producer, with product as bullion, ore, and concentrates. A small output of ore from the Gladstone mine was concentrated or sent to the sampler. A small output from the Quito mine was concentrated. Several cars of ore were shipped to the sampler from the Stanley mine. A small production was made from the Lincoln and Elliott and Barber mines. A small production was shipped from the Almaden mine, on Fall River.

Operating mills at Idaho Springs in 1914 were the Argo, Combination, Jackson, and Newton.

In the Jackson and Cascade districts producing mines were the Black Eagle, Chicago Mountain, Dorit, Humboldt, and P. T. mines.

Montana (Lawson and Dumont) district.—The Montana district in 1914, from 10 mines, produced 306 tons, carrying $3,784 in gold, 9,480 ounces of silver, 8,970 pounds of copper, and 25,392 pounds of lead, with a total value of $11,209, as against $22,893 in 1913. All but a small quantity of ore went to smelters. Producing mines were the Albro, Big Chance, Crockett, Jo Reynolds, Little Giant, and Syndicate.

Trail Creek (Lamartine and Freeland) district.—The Trail Creek district in 1914, from 13 mines, produced 4,236 tons of ore, yielding $31,264 in gold, 12,454 ounces of silver, 12,300 pounds of copper, 163,941 pounds of lead, and 24,118 pounds of zinc, with a total value

[1] For description see U. S. Geol. Survey Mineral Resources, 1912, pt. 1, p. 653, 1913; Eng. and Min. Jour., Aug. 30, 1913, pp. 385–389; and Colorado State Bur. Mines Twelfth Bienn. Rept., 1911–12, p. 80, 1913; see also Roller, A. H., and Curran, H. T., Ore treatment at the Argo mill: Eng. and Min. Jour., p. 1, July 4, 1914. See also Eng. and Min. Jour., Aug. 1, 1914, p. 217.
Pearce, Jackson A., Cyanidation of Clear Creek and Gilpin County sulphides: Min. and Sci. Press, Nov. 28, 1914, pp. 833–837.
Also see Heizer, O. F., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 87–90, 1914.
Parmelee, H. C., Cyanidation of low grade sulphide ores in Colorado: Metall. and Chem. Eng., July, 1915, pp. 421–425.

of $47,411, as against $72,706 in 1913. Lead-zinc ore from the Ben Harrison mine was concentrated at the Newton mill and yielded lead and lead-zinc concentrates. The new Oneida 50-ton cyanide mill went into operation in December, 1914, and precipitates and concentrates were shipped early in January, 1915. Dry and lead ores were shipped from the New Era mine, and the concentration plant on the property was operated part of the year. Milling and smelting ores were shipped from the Centurion-Donaldson-Rockford group. Smelting ore was shipped from the Lamartine, Freeland Extension, and United Freeland mines.

CONEJOS AND RIO GRANDE COUNTIES.

Platoro-Gilmore-Summit district.[1]—Some development was made in this district, which is 45 miles southwest of Monte Vista, near the Rio Grande-Conejos County line. The Guadaloupe Mining Co.'s property is opened by an adit 590 feet long and an 85-foot drift, of which 300 feet of adit and the 85-foot drift were done in 1914. The shaft on the Smuggler-Sunbeam property was sunk 65 feet in 1914, making a depth of 135 feet. The mine is also opened by an 160-foot adit. The No. 10 prospect between Platoro and Stunner was down 45 feet. Development work was done on the Glacier and Bryan prospects.

COSTILLA COUNTY.

Grayback district.[2]—A small quantity of placer gold was recovered by sluicing in the district.

CUSTER COUNTY.[3]

From 14 mines in Custer County in 1914 there were sold or treated 870 tons of ore, from which were recovered $3,365 in gold, 15,975 ounces of silver, valued at $8,834; 3,481 pounds of copper, valued at $463; 9,692 pounds of lead, valued at $378; and 4,470 pounds of zinc, valued at $228, with a total value of $13,268, as compared with $22,377 in 1913. The yield of silver increased somewhat and the yield of lead increased slightly, but the output of gold decreased appreciably, and that of copper slightly. The greater part of the ore was shipped to smelter.

Dump ore from the Bassick mine, at Ilse, was treated in the 35-ton cyanide plant and shipped to smelters. Smelting ore was shipped from the Bismuth, Hector, Immortal, King of the Carbonates, Loomis, Nodoway, Steiner, and Van Emmett mines.

The Terrible mine,[4] unwatered in 1913, but with no output in 1913, was idle in 1914.

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[1] For discussion of the geology of the district see Hills, R. C., Ore deposits of the Summit district, Rio Grande County, Colo.: Colorado Sci. Soc. Proc., vol. 1, pp. 20–36, 1883. Raymond, R. W., Mines and mining west of the Rocky Mountains, vol. 10, p. 329, 1875. Emmons, W. H., The enrichment of sulphide ores: U. S. Geol. Survey Bull. 529, p. 226, 1913.

[2] For discussion of geology see Patton, Smith, Butler, and Hoskins, Geology of the Grayback mining district, Costilla County, Colo.: Colorado State Geol. Survey Bull. for 1909, No. 2, 1910.

[3] For discussion of geology see Cross, Whitman, Geology of Silver Cliff and the Rosita Hills, Colorado: U. S. Geol. Survey Seventeenth Ann. Rept., pt. 2, pp. 263–403, 1896, and Emmons, S. F., The mines of Custer County: Idem, pp. 405–472.

[4] For discussion of geology see Hunter, J. F., Some cerusite deposits in Custer County, Colo.: U. S. Geol. Survey Bull. 580, pp. 25–37, 1914.

DOLORES COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Dolores County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	8	17,802	[a] $12,432	[a] 178,816	801,819	3,079,341	2,596,232	$525,599
1914	10	6,905	7,973	86,526	350,278	492,023	366,549	140,292
Increase (+) or decrease (−)	+2	−10,897	−4,459	−92,290	−451,541	−2,587,318	−2,229,683	−385,307

[a] Includes placer production.

Dolores County in 1914 produced 6,905 tons of ore, yielding $7,973 in gold; silver, valued at $47,849; copper, at $46,587; lead, at $19,189; and zinc, at $18,694—a total value of $140,292, as compared with $525,559 in 1913.

Lone Cone (Dunton) district.—A small shipment of ore was made from the Emma mine.

Pioneer (Rico) [1] *district.*—This district in 1914 produced 6,864 tons of ore, yielding $6,542 in gold, 80,844 ounces of silver, 350,196 pounds of copper, 491,177 pounds of lead, and 366,549 pounds of zinc, with a total value of $135,675, as compared with $503,391 in 1913. The ore was lead, lead-zinc, copper, and iron; part of the lead-zinc ore was shipped to the Sutton, Steele & Steele plant, part to the Western Chemical Co., Denver, and part to Coffeyville, Kans.; the lead and copper ore went to smelters at Durango, Ouray, Pueblo, and Salida, Colo., and Salt Lake City, Utah; and the iron ore was sold for its iron contents alone, for use in the treatment of vanadium [2] ores, at Vanadium, Colo.

The Rico-Wellington group was the principal producing property. The public report of this company states:

> Early in 1914 we found it necessary to discontinue shipments of copper ore until arrangements could be made with the railroad for a reduction in freight rates. This was allowed, and we started to ship on our new rate July 23, 1914, shipping two cars a day until August 12, when the smelters stopped quotations on copper and silver on account of the war. We have done 2,004 feet of work during the year, the biggest part of which is development and prospect work in new territory. We have succeeded in opening up and shipping a fair tonnage of carbonate ore from new ground and we believe from the information gained in mining this ore that we shall be able to open up still more in the future. We have also found two new beds of copper ore in new territory paralleling the old stopes, but farther away from the fissure and nearer the surface than any copper ore so far discovered. The first copper strike was made in an upraise from the main Wellington tunnel in about 850 feet from the portal and 63 feet above the tunnel level. The second strike was made in another upraise about 150 feet beyond the first raise and 93 feet above the main level. A drift was made from the top of each raise and the ore beds were found one directly above the other. * * *
>
> There is also a large percentage of the ore reserve reported in 1913 annual report still untouched, awaiting better market conditions. In addition to this we have a large tonnage (estimated at several hundred thousand tons) of almost pure iron sulphide,

[1] For discussion of geology see Ransome, F. L., The ore deposits of the Rico Mountains, Colorado: U. S. Geol. Survey Twenty-second Ann. Rept., pt. 2, pp. 229–398, 1901.

[2] For discussion of treatment of vanadium ores see Moore, R. B., and Kithil, K. L., A preliminary report on uranium and vanadium: U. S. Bur. Mines Bull. 70, p. 74, 1914.

carrying about 2 per cent copper and 3 ounces of silver, which we expect to be able to treat locally as soon as the company's finances will allow us to complete tests already started and to install the necessary equipment. * * *

	Feet.
Total footage development for 1914	2,004
Previous footage	12,963
Total footage kept in repair to date	14,967

ORE PRODUCTION.[1]

	Short tons.
Copper ore:	
Moist weight	2,385.28
Moisture (4.499 per cent)	107.31
Dry weight	2,277.97
Lead ore:	
Moist weight	2,045.39
Moisture (21.6 per cent)	441.84
Dry weight	1,603.55
Iron ore:	
Moist weight (sold at flat rate per moist tons)	656.26
Zinc concentrates:	
Moist weight	71.24
Moisture (5.5 per cent)	3.92
Dry weight	67.32

NET VALUES.

Copper ore	$15,194.83, or	$6.6703 a ton.
Lead ore	12,486.04, or	7.7865 a ton.
Iron ore	2,547.04, or	3.8811 a ton.
Zinc concentrates	38.06, or	.5653 a ton (royalty only).
	30,265.97	

Lessees (including the Rico-Argentine Co.) on the Rico Mining Co.'s group also shipped a large quantity of ore of various classes. Other producing mines were the Badger, David, Iron, Lillian D., Newman, Rico Consolidated group, and South Park.

DOUGLAS COUNTY.

A small quantity of placer gold was recovered by sluicing in Newlins Gulch, near Parker, in Douglas County, in 1914.

EAGLE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Eagle County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	29	47,488	$41,220	301,380	41,368	1,351,205	6,683,643	$663,403
1914	24	49,377	47,194	127,080	28,105	1,177,385	7,522,098	550,752
Increase (+) or decrease (−)	−5	+1,889	+5,974	−174,300	−13,263	−173,820	+838,455	−112,651

[1] Ores sampled Jan. 1 to Dec. 31, 1914.

Eagle County in 1914 produced 49,377 tons of ore, yielding $47,194 in gold; silver, valued at $70,275; copper, at $3,738; lead, at $45,918; zinc, at $383,627—a total value of $550,752, as compared with $663,403 in 1913. The decrease in silver output was due to the heavy decrease in the yield from the new (in 1913) silver district at Eagle; the lead decrease was due to decreased shipments of smelting ore from Red Cliff; the increase of 838,455 pounds of zinc was due to increase in zinc concentrates from Red Cliff. The county in 1914 surpassed Summit County in yield of zinc, taking second place to Lake. There were 24 producing mines, as against 29 in 1913. The ore sent to separating mills increased, but the ore to smelters decreased.

Battle Mountain (Red Cliff)[1] *district.*—Red Cliff district in 1914 produced 48,925 tons of ore, yielding $45,329 in gold, 111,646 ounces of silver, 23,414 pounds of copper, 1,175,377 pounds of lead, and 7,522,098 pounds of zinc—a total value of $539,650, as compared with $549,088 in 1913. An increased tonnage of lead-zinc ore was mined and milled from the Iron Mask mine in 1914. The output of the mill[2] was zinc, lead, and iron-manganese concentrates. The crude ore milled carries about 1–5 per cent lead, 17 per cent zinc, 30 per cent iron, 26 per cent sulphur, and 2 per cent silica.[3] Lessees on the Bleak House-Wilkesbarre mine shipped lead ore to lead smelters and zinc-lead-silver ore to the concentration-flotation plant at Leadville. From the Black Iron mine, lead oxidized ores, zinc oxidized ores, and lead-zinc sulphide ores were shipped. Lessees on the Champion and the Ground Hog mines shipped dry gold-silver sulphide and copper sulphide ores. Other mines from which ore was shipped were the Alligator, Alleghany, Alpine, Ben Butler, Black Bear, Foster Combination, Little Mary, Pine Martin, Poorman-Tram, Star of the West, Tip Top, and Wyoming Valley.

Eagle or Brush Creek district.—The yield from this new (in 1913) district fell off heavily in 1914. Shipments of silver-copper ore were made from the North Dakota and North Dakota Extension mines, and silver ore from the Lady Belle mine.

Girard Mountain district.—A small tonnage of silver-copper-gold ore was shipped from the California mine.

Holy Cross district.—Small shipments of gold ore from the Alaska mine, gold-silver ore from the Gold Bug-Spread Eagle mine, and gold-silver-lead ore from the Aurora mine were made.

Mount Egley district.—A small quantity of gold-silver ore, carrying some lead, was shipped from the Ohio mine.

EL PASO COUNTY.

Blair Athol district.—A small shipment of copper ore was made from a surface deposit of copper oxidized ore in sandstone at Blair Athol, about 6 miles north of Colorado City.

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[1] For discussion of geology see Means, A. H., Geology and ore deposits of Red Cliff, Colo.: Econ. Geology, vol. 10, No. 1, pp. 1–27, January, 1915. Also Argall, Philip, Siderite and sulphides in Leadville ore deposits: Min. and Sci. Press, July 11, 1914, p. 52 (siderite at Red Cliff).

[2] For description see Hanington, C. H., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 78–79, 1914.

[3] Hanington, C. H., Colorado State Bur. Mines Twelfth Bienn. Rept., 1911–12, p. 73, 1913.

FREMONT COUNTY.

An appreciable tonnage of copper-silver-gold ore was shipped from the Green Mountain mine at Parkdale.

GARFIELD COUNTY.

A small tonnage of gold-silver ore, carrying a good commercial content of gold, was shipped from the Gray Eagle mine, near Newcastle.

GILPIN COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Gilpin County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	122	94,156	[a]$687,101	[a]273,207	837,974	1,210,341	8,589	$1,035,740
1914	123	52,839	573,553	145,237	726,579	499,718	12,980	770,655
Increase (+) or decrease (−)	+1	−41,317	−113,548	−127,970	−111,395	−710,623	+4,391	−265,085

[a] Includes placer production.

Gilpin County in 1914 produced 52,839 short tons of ore, against 94,156 tons in 1913. There were 73 companies or individuals operating deep mines or groups of mines, and there were 50 small lots of ore produced from other properties, a total of 123 mines from which ore was derived, as against 122 in 1913.

The yield of gold was $573,553; the silver yield was valued at $80,316; copper, at $96,635; lead, $19,489; and zinc, $662—a total value of $770,655, as against $1,035,740 in 1913. The ore sent to amalgamation and concentration mills in Gilpin County (and to amalgamation, cyanidation, and concentration mills at Idaho Springs) decreased materially, with a consequent decrease in gold-silver bullion and precipitates. The ore to mills for concentration only and the resulting concentrates decreased heavily. The crude ore sent to smelters decreased materially.

The Polar Star and U. P. R. custom amalgamation-concentration mills treated considerably less ore than in 1913; the Frontenac mill, to which a large quantity of Frontenac ore was sent in 1913, was idle in 1914; the Iron City concentration mill was operated steadily in 1914; the Stroehle (or Horn) concentrating mill was operated for a period; and the Smith amalgamation-concentration mill was operated on crude and dump ores. The Carr (Most) mill, with new machinery placed in the old Randolph mill, was operated during the last days of December. The equipment of this mill is as follows: Crusher, Challenge feeders, ten 750-pound stamps (53 drops to the minute), amalgamating plates, 2 Gilpin County bumping tables, 6 Wilfley tables.

Almost all the ore of Gilpin County is dry siliceous, there being some ore carrying copper above 2½ per cent and a small quantity carrying lead above 4½ per cent. Concentrating ore in 1914 made

practically all dry concentrates, there being some lead concentrates produced and a few cars of zinc concentrates.

Southern area (Central City, Black Hawk, Nevadaville, Russell Gulch).—The old districts of the main area of Gilpin County are so indefinite that separation of output by districts has been abandoned.

In the immediate vicinity of Central City, producing mines were the Bonanza, Corydon, East Boston, Huddleston, and Troublesome.

In the Enterprise district, below Black Hawk, producing mines were the Coaley, Galena, and Little Kingdom.

Producing mines in the district embracing Gunnell Hill and Eureka and Prosser gulches, were the Eureka mine and the Gunnell group. The Gunnell (or Tremont) mine was worked from the Argo tunnel and a large output of ore was sent to the Argo mill.

Producing mines in the district embracing the town of Black Hawk and the Gregory, Bobtail, and Bates hills, were the Americus, Bates, Chicago-Carr, Colorado-Carr, Dump Lode, Fisk, Gilpin-Orion, Homer, Nemeha, O. K., Maine-Hamlet, Running Lode, Senator, U. P. R., and Whitesides.

Producing mines in the district embracing Illinois and Leavenworth gulches and the east portion of Quartz Hill were the Alps, Bezant, East Calhoun and West Calhoun, Egyptian, Ethan Allen, German and Belcher, and Wood. In this district pitchblende has been mined from time to time at the Wood, Kirk, Alps, Calhoun, and German and Belcher mines.

Producing mines in the Lake Gulch district were the Justice, Pittsburg, Success, St. Louis, and West Notaway.

In the vicinity of Nevadaville, among producing mines were the Barnes, Belden, Columbia, Divernon, First National Kansas, Hubert, Phoenix-Burroughs, Pozo-Dyke, Ralls County, San Juan, Shanks Tunnel, Rome-Gardner, and West Baker. The Dyke mine was worked from the Newhouse tunnel level and the ore was shipped to Idaho Springs, but the contents have been credited to Gilpin County. Some zinc concentrates were recovered from the milling of ore from the Hubert mine.

In the Quartz Valley district, producing mines were the Castle Rock, Buckeye, Hayseed Tunnel, Keystone, and Margaret Glennon.

The Russell Gulch district is the most important in Gilpin County. Among producing mines were the Argo, Adduddell, Denbigh, Druid, Federal, Frontenac, Gem, Iron, Hampton, Lillian, Old Town group, Richardson, Rockford, Saratoga, Square Deal (East Notaway), Topeka, and Two Forty.

Northern districts.—The outlying districts in Gilpin County are the Vermilion district, 4 miles northwest of Central City; Pine district, 7 miles northwest of Central City; Independence and Union districts, 9 miles north of Central City, embracing Perigo and Rollinsville, Lump Gulch, and Moon Gulch sections; Phoenix district, along the north edge of the county, near the Boulder County line; Silver Lake district, 5 miles north of Central City, and Hawkeye district, 7 miles north of Central City and 4 miles east of Apex.

There were 1,287 tons of ore from these districts sold or treated in 1914. The yield had a total value of $14,449, of which $10,044 was gold. Nearly all the ore was milled. Ore from the Smuggler mine was treated by amalgamation. There was a small yield from the Perigo mine. A test lot of ore was sent to Smith mill, at Central City

from the North Star mine, in the Vermilion district, and a test lot from the Golden Rod mine, on Silver Creek. Silver-lead ore was shipped from the Alaska mine, in the Hawkeye district.

The new 10-stamp 50-ton amalgamation mill at the London mine was operated for a period.

GRAND COUNTY.

A small shipment of lead-silver ore was made from the Ready Cash mine, on Williams Fork. Development work was done on the Mollie Groves property, in the Blue Ridge district. There is a 30-ton Partridge hot blast furnace on the ground at this property, but not erected.

GUNNISON COUNTY.[1]

Mine production of gold, silver, copper, lead, and zinc in Gunnison County, Colo., 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	19	4,301	$10,189	87,488	21,864	196,728	292,875	$91,478
1914	12	6,018	13,033	59,036	11,188	317,974	525,000	86,344
Increase (+) or decrease (−)	−7	+1,717	+2,844	−28,452	−10,676	+121,246	+232,125	−5,134

[a] Includes placer production.

The output from Gunnison County in 1914, from deep and placer mines, was $13,033 in gold; the silver yield was valued at $32,647; copper, at $1,488; lead, $12,401; zinc, $26,775—a total value of $86,344, as compared with $91,478 in 1913.

Box Canyon district (*Waunita Hot Springs*).—There was no output from this district in 1914.

Cochetopa district (*Sillsville*).—No production was made in 1914 in this district.

Elk Mountain district (*Gothic and Crested Butte*).—A car of lead ore from the Doctor mine was shipped to Salida, and a car of ore carrying silver, gold, and copper was shipped from Iola by the Elk Mountain Co. to the Copper plant at Ouray. Several cars of lead-zinc ore were shipped from the Keystone mine to Sutton, Steele & Steele, Denver.

Gold Brick District (*Ohio City*).—The Carter mine was operated continuously, and the 20-stamp amalgamation and concentration mill [2] was operated for 3 months in 1914. A car of ore was shipped from the Gray Eagle mine. The Gold Links mine and mill remained idle.

Quartz Creek district (*Pitkin*).—This district was the most important producing district in 1913, but in 1914 only a few cars of ore were shipped from it. Ore carrying silver, lead, gold, and copper was shipped from the Fairview mine.

[1] For discussion of Geology see Hill, J. M., Notes on the economic geology of southeastern Gunnison County, Colo.: U. S. Geol. Survey Bull. 380, pp. 21–40, 1909.

[2] For description see Carter, C. M., Colorado State Bur. Mines Thirteenth Bien. Rept., 1913–14, p. 96, 1914.

Rock Creek district (*Marble*).—Lead-zinc ore from the Lead King mine was shipped to the Sutton, Steele & Steele mill, Denver.

Tin Cup district.—A considerable quantity of lead-silver ore was shipped from the Independence mine on Italian Mountain. Lead silver ore was shipped from the Tin Cup mine. The Tin Cup Gold Dredging Co., on Willow Creek, near Tin Cup, operated its dredge during part of the year and produced a substantial quantity of gold bullion.

Tomichi district (*Whitepine*).[1]—The Morning Star mine was operated continuously, and shipments of lead-zinc ore were made to various zinc plants.

HINSDALE COUNTY.[2]

Hinsdale County produced in 1914 from 7 mines 118 tons of ore, yielding $170 in gold; 5,987 ounces of silver, valued at $3,311; 17,098 pounds ofcopper, valued at $2,274; and 5,723 pounds of lead, valued at $223, with a total value of $5,978, against $73,002 in 1913.

Galena district.—Copper ore was shipped from the Frank Hough mine and silver ore from the Hoffman mine to Ouray. Small lots of ore were shipped from the Long Taw and Wall Street mines.

Lake district.—Small lots of ore were shipped from the Belle of the East-Cora-Sulphuret mines, and from the Iron Cap-Fanny Fern-Ruby No. 2 mines.

LAKE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Lake County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	91	528,311	$1,023,631	3,400,318	1,923,987	29,286,183	93,842,857	$9,919,433
1914	96	547,463	1,571,451	3,810,830	2,382,910	26,784,615	78,763,334	9,057,297
Increase (+) or decrease (−).	+5	+19,152	+547,820	+410,512	+458,923	−2,501,568	−15,079,523	−862,136

In 1914 the value of the yield of Lake County (despite substantial increases in production of gold, silver, and copper), because of the decreased production of zinc and the lower average price, was $9,057,297, as compared with $9,919,433 in 1913. Teller County made a yield of $12,045,364, and thus held first place in value in output, which Lake County had held for 1912, but lost in 1913. Teller, Lake, and San Miguel remained the order of counties in point of ore shipped or treated. The Lake County output of ore was 20 per cent and the value 27 per cent of the respective State totals. This county was again first in the production of silver, copper, lead, and zinc; in the production of gold it followed Teller and San Miguel, holding third place, which was taken from Ouray County in 1912.

[1] For discussion of geology see Crawford, R. D., Geology and ore deposits of the Monarch and Tomichi districts, Colorado: Colorado Geol. Survey Bull. 4, 1913.

[2] For discussion of geology see Irving, J. D., Ore deposits in the vicinity of Lake City, Colo.: U. S. Geol. Survey Bull. 260, pp. 78–84, 1905; Ore deposits of the Ouray district, Colo.: U. S. Geol. Survey Bull. 260, pp. 50–77, 1905. Irving, J. D., and Bancroft, Howland, Geology and ore deposits near Lake City, Colo.: U. S. Geol. Survey Bull. 478, 128 pp., 1911. Larsen, E. S., The economic geology of Carson Camp, Hinsdale County, Colo.: U. S. Geol. Survey Bull. 470, pp. 30–38, 1911.

Of the State total, Lake County produced 43 per cent of the silver, 36 per cent of the lead, 36 per cent of the copper, and 81 per cent of the zinc.

In 1914, from 96 deep mines, there were sold or treated 547,463 tons of ore, as against 528,311 in 1913. The gold production was $1,571,451; the silver yield was valued at $2,107,389; copper, $316,927; lead, $1,044,600; zinc, $4,016,930—a total value of $9,057,297.

Lake County includes the Leadville, St. Kevin or Sugar Loaf, Twin Lakes, Lackawanna Gulch, and Big English Gulch districts.

Leadville (California) district.[1]—Of a total of 547,463 tons of ore mined in 1914 in this county, 532,702 tons were from the Leadville district. The yield was $1,445,637 in gold, 3,623,839 ounces of silver, 2,370,316 pounds of copper, 26,663,744 pounds of lead, and 78,763,334 pounds of zinc, with a total value of $8,821,688, out of a county total of $9,057,297.

As compared with 1913, this output shows a small increase in quantity of ore, an increase of $516,431 in gold, of 463,023 ounces of silver, and of 463,851 pounds of copper, but a decrease of 2,431,551 pounds of lead and of 15,079,523 pounds of zinc.

The output of zinc carbonate ore decreased from 135,760 tons averaging 27.45 per cent zinc in 1913 to 113,881 tons of 24.3 per cent zinc in 1914. The zinc sulphide ores sold or treated at Leadville increased from 97,704 tons of 23 per cent zinc in 1913 to 111,947 tons of 21.2 per cent zinc in 1914.

CLASSIFICATION OF LEADVILLE ORES.

The following table shows the classification of Leadville ores:

Classification of Leadville ores.

Character.	Quantity.	Quantity.	Percentage.
Sulphide:	*Short tons.*	*Short tons.*	
Zinc-iron-lead (zinc blende: Pyrite with a little galena)	111,947	111,947	21
Iron (pyrite with a little copper, gold, silver, and lead)	174,610		
Iron (pyrite with a little copper, gold, silver, and lead over 4½ per cent dry lead)	17,100	195,612	37
Iron (pyrite with gold, silver, lead, and copper over 2½ per cent dry copper)	3,902		
Total sulphide	307,559	307,559	58
Oxide:			
Lead	29,288	29,423	6
Copper	135		
Iron and iron-manganese (silver, and some lead) flux	48,839	48,839	9
Zinc carbonate and silicate	113,881	113,881	21
Total oxide	192,143	192,143	36
Siliceous (oxide) *a*:			
Gold-silver	33,000	33,000	6
Grand total	532,702	532,702	100

a All the siliceous oxide ore is also dry. The greater part of this siliceous oxide carries a heavy excess of iron over silica; some carries iron and silica in equal quantities; a small quantity carries iron in excess of silica, but carries gold and silver in quantity to take material out of mere flux class. Metallic gold, in quantity, 4,773.91 fine ounces, valued at $98,685, and 1,293 fine ounces of silver came from less than a ton of ore, from siliceous oxide and sulphide ore bodies.

[1] For discussion of geology see Emmons, S. F., Geology and mining industry of Leadville, Colo.: U. S. Geol. Survey Mon. 12, 1886. Emmons, S. F., and Irving, J. D., The Downtown district of Leadville, Colo.: U. S. Geol. Survey Bull. 320, 1907. Argall, Philip, Siderite and sulphides in Leadville ore deposits: Min. and Sci. Press, July 11 and 25, 1914, pp. 50–54; 128–135.

Classification of Leadville ores—Continued.

Character	Quantity.	Recovered contents.					Average.				
		Gold.	Silver.	Copper.	Lead.	Zinc.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*		*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Sulphide:											
Zinc-iron-lead	111,947	(a)	(a)	(a)	(a)	(b)	c 0.03	c 5.37	(c)	c 8.74	c 21.2
Iron pyrites	174,610	31,770.74	2,343,943	1,720,872	4,221,091	.....	.182	13.42	0.49	1.21	.....
Lead sulphide	17,100	4,989.00	290,906	84,688	5,245,333	.....	.292	17.01	.25	15.34	.....
Copper sulphide	3,902	1,200.18	109,068	344,490	51,992	.....	.308	27.95	4.41	.67	.....
Oxide:											
Lead	29,288	9,314.94	190,428	60,002	5,227,960	.....	.318	6.50	.10	8.93	.....
Copper	135	10.70	706	14,035	.....	.....	.079	5.23	5.20	.....	.....
Iron flux	48,839	192.45	220,831	34	1,271,781	.....	.004	4.52	.....	1.30	.....
Zinc	113,881	.....	.....	.....	.....	(b)	.....	.....	.....	.....	d 24.3
Siliceous	33,000	15,361.23	166,159	94,300	539,820	.....	.465	5.04	.14	.82	.....
Metallics: (Sulphide and oxide)	.....	4,773.91	1,293	.....	.....	.....	.....	.....	.....	.....	.....
Total	532,702	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Character.	Recovered contents.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry, iron, and siliceous ores e	256,449	52,098.33	2,732,226	1,815,206	6,032,692	.....
Copper ores f	4,037	1,210.88	109,774	359,025	51,992	.....
Lead ores g	46,388	14,303.94	481,334	144,690	10,473,293	.....
Zinc ores h	143,848	.90	398	49	11,041	55,680,382
Lead-zinc ores i	81,980	2,318.64	300,107	51,346	10,094,726	23,082,952
Total	532,702	69,932.69	3,623,839	2,370,316	26,663,744	78,763,334

a Estimated recovery, as lead and iron concentrates and zinc residues.
b Zinc figured as spelter, or as zinc in zinc oxide.
c Average assay crude ore, mostly milled. (Lead wet assay.)
d Average assay crude. All to zinc smelters.
e Includes siliceous oxide, iron, and iron-manganese (silver), largest part of iron pyrite. Smelting ores. Also includes metallics.
f Sulphide and oxide. Smelting ores.
g Sulphide and oxide lead ores. Smelting ores.
h Sulphide and carbonate. To smelters.
i Sulphide. Greater part to magnetic separating mills.

The course of treatment of Leadville ores, from mine mouth to market, was shown graphically in Mineral Resources for 1911, part 1, 1912, page 547, figure 1. With the exception of the quantity of ore, the flow sheet for 1911 applies for 1914.

During 1914 a 50-ton zinc oxide plant[1] was completed, but was operated for a short time only in 1914. The Leadville district mill was remodeled and the minerals separation flotation process added, and after considerable experimentation, was operated on low-grade lead-zinc sulphide ores from various Leadville mines and dumps and from Red Cliff.

MINES REVIEW.

California Gulch, Iron Hill, Breece Hill mines as opened by the Yak tunnel.—Of the mines operated by the Yak Co., through the Yak tunnel, the bulk of the ore continued to come from the property of the Cord Mining Co (Minnie Lee claim). Besides the operations of the Yak Co. and its auxiliary company, the Leadville Exploration &

[1] For description see Min. and Sci. Press, Mar. 20, 1915, pp. 433–438.

Mining Co., there were shipments of ore by lessees from other mines controlled and developed by the Yak Co. Other mines from which ore was shipped were the Comstock (or Hopemore), Diamond, Cornelius, Dolly B., Habendum, Logan, Malvina, M. N. Fraction, Polaris, Tenderfoot, Resurrection, Rubie, Sierra Nevada, South Cord, Toyania, Vega, and White Cap. The bulk of the ore was iron sulphide, which was shipped to lead smelters in Colorado. Zinc-lead sulphide ore went to the Western Chemical Co., at Denver, to Oklohoma smelters, and to Tiltonville, Pa. Some low-grade zinc carbonate ore was shipped from the Sierra Nevada mine. Lead oxide from the Dolly B., iron oxide from the Logan, iron and siliceous oxide from the Diamond, iron oxide from the Dolly B.-Polaris, and iron oxide from the Vega mine was shipped to lead smelters. Zinc-lead sulphide was shipped from the Rubie mine to zinc smelters and lead-zinc concentrating plants. Nearly all that remained of the old dump of iron concentrates at the closed magnetic separation plant at the mouth of the Yak tunnel was removed to lead smelters.

Iron Hill.—The Iron Silver Mining Co., according to its annual report for the year ending December 31, 1914, says:

Development in the Moyer, Tucson, and Blind Tom mines totaled 4,914 feet. The main shaft of the first named was retimbered from No. 2 level to the surface, and the old boiler plant was reerected in another locality. These alterations resulted from settling of abandoned stopes. The east oreshoot continued to yield most of the Moyer output, but it is now nearly worked out. It has been possible also to sell low-grade mixed sulphide ore and so mainatin the yield. Development is being continued, and the area around both shafts to be prospected to the middle of the blue limestone formation. The area below this is receiving systematic geologic study, but diamond-drilling does not offer encouragement. The future of the mine is uncertain. In the Tucson, development was slightly greater than in 1913, covering a wide area, which outlined the main zone of mineralization. All of the known carbonate ore bodies were extracted, and prospecting did not reveal others in the oxidized area of the mine. One hundred feet below No. 4 level an important zinc-lead sulphide mass was found. On No. 8 level, 399 tons of siliceous silver-bearing ore, with a net value of $66.10 per ton, was mined. This occurs in thin seams and incrustations lining the small cavities surrounded by dense quartzite, resulting in small production and high cost.

The output of the property was as follows:

Output of Moyer, Tucson, and Blind Tom mines, in short tons.

Class of ore.	Moyer.	Tucson.	Blind Tom.	Lessees.
Zinc-lead sulphide	6,781	12,416	.....	3,684
Low-grade zinc-lead sulphide	7,134	.....	.....	.....
Lead sulphide	9,658	.....	.....	422
Iron sulphide	61	209	.....	766
Lead carbonate	17	558	.....	2,992
Zinc sulphide	.....	312	.....	281
Siliceous sulphide	.....	399	.....	.....
Copper sulphide	.....	38	.....	.....
Iron oxide	.....	.....	317	437
Zinc carbonate	.....	.....	78	5,930
Total	23,651	13,932	395	14,512

Metals contained in these varied ores amounted to 923 ounces gold, 328,027 ounces silver, 10,608,734 pounds lead, 17,396,362 pounds zinc, 12,751 pounds copper, and 5,247,433 pounds iron.

Revenue from sales of ore, royalties, and miscellaneous totaled $421,661. The profit was $174,629, of which $100,000 was paid in dividends. The surplus on December 31, 1913, was $353,539, and at the end of 1914, $428,168.[1]

[1] See Min. and Sci. Press, Apr. 24, 1915, p. 671; Min. and Eng. World, Apr. 24, 1915, p. 787.

Lead-zinc sulphide ore from the A Y and Minnie mine was shipped to Sand Springs, Okla., and to Pueblo, Colo. Lead, iron, and lead-zinc sulphides were shipped from the Louisville mine. Lead oxidized ore was shipped from the Gilt Edge mine, in California Gulch. Lead oxidized and iron sulphide ores were shipped from the Adelaide mine on North Iron Hill; lead oxide and siliceous oxide from the Mikado (Commerce) mine; zinc carbonate from the Smuggler mine, and lead sulphide from the Humboldt mine.

Breece Hill.—Breece Hill and South Evans Gulch embrace the chief mines of the gold belt.

Lessees on the property of the Ibex Mining Co. continued to ship iron pyrite, copper and lead oxide, lead sulphide, lead-zinc sulphide, and zinc carbonate ores, as well as considerable metallic gold. Iron sulphide and copper sulphide ores were shipped from the Garbutt, Mary Alsberg, Maud Hicks, Nonie, and St. Crispen mines. Iron sulphide and zinc carbonate ores were shipped from the St. Louis tunnel. A considerable quantity of hematite fluxing ore and siliceous ore was shipped from the Breece-Iron mine. Siliceous oxide from the Big Four, Great Hopes, President, and Robert Burns; zinc carbonate from the Highland Chief and Eliza; lead oxide from the Belgian and Fannie Rawlings; and lead oxide and zinc carbonate from the Elk, were shipped to smelters.

South Evans Gulch-Little Ellen Hill.—The ores of this vicinity carry appreciable gold and silver content. Lead sulphide and lead oxide ores were shipped from the New Monarch mine. Siliceous oxide and sulphide ores were shipped from the Silver Spoon, and lead oxide, lead sulphide, siliceous oxide and sulphide, and lead-zinc sulphide from the Valley mine. Lead oxide and zinc carbonate ores were shipped from the Little Ellen mine.

Stray Horse Gulch.—Siliceous oxide ore was shipped from the Double Decker and the Alleghany mine.

Carbonate Hill.—The bulk of the zinc carbonate at Leadville came from mines on Carbonate Hill. Large tonnages were shipped from the Big Chief, Castleview, Evalyn, Maid of Erin, Wolftone, and other mines of the Western Mining Co. through the Wolftone shaft, and from the Star Consolidated mines. Iron-manganese and lead oxide ores were also shipped from the Star mines. From the Star mines iron-manganese ore was shipped to the steel plant at Pueblo. This is the first shipment since 1909 of manganese ore from Leadville for use in the manufacture of steel. Lead oxide and iron-manganese ores were shipped from the Star of the West mine. Iron-manganese ore was shipped from the Castleview, Evalyn, and Yankee Doodle mines.

Fryer Hill.—Iron-manganese, lead oxide, and zinc carbonate ores were shipped from the Little Chief; iron-manganese and zinc carbonate from the Chrysolite and Robert E. Lee mines; iron-manganese from the Climax, Gambetta, Seneca, Matchless, and Shamrock; siliceous oxide from the North Side; and siliceous oxide and iron-manganese from the Amie and Dunkin mines. Lead sulphide and lead-zinc sulphide ores were shipped from the Denver City mine. Lead-zinc sulphide and iron-manganese ores were shipped from the Result and Forest City mines of the Small Hopes-Boreel Co.

Printer Boy Hill.—Siliceous oxide, lead oxide, and some metallic gold were shipped from the Lilian mine and siliceous oxide from the Lovejoy mine.

Rock Hill.—Lead oxide, carrying considerable iron and manganese, and zinc carbonate ores were shipped from the La Plata mines; and lead sulphide from the Crown Point mine, on Rock Hill, east of Iron Hill, across California Gulch.

Iowa Gulch.—A small shipment of siliceous oxide ore was made from the Dyer Mountain mine.

St. Kevin-Independence (or Sugar Loaf) district.—Along the base of the Sawatch Range, including St. Kevin and Sugar Loaf Mountain, is a mineralized region, from which ore has been shipped since the early days of Lake County. In 1914, siliceous oxide and sulphide silver-gold ores were shipped from the Dinero and Amity, St. Kevin and Sugar Loaf consolidated mines, and gold-silver ore from the Jimmie Swisher mine.

Twin Lakes and Lackawanna Gulch districts.—Small lots of gold ore were shipped from the Belle of Granite and the Anchor mine. The Mount Champion mine, in Lackawanna Gulch, was operated continuously and the 100-ton amalgamation-concentration mill [1] was operated from February to June, inclusive. The product was smelting ore, bullion, and concentrates. A shipment of very good grade of gold ore was made from the Lackawanna Belle mine.

Big English Gulch.—A shipment of gold-silver-copper ore was made from the Winthrop mine.

LA PLATA COUNTY.

Mine production of gold, silver, copper, and lead in La Plata County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1913	24	7,403	$312,891	121,122	113,897	4,455	$403,899
1914	27	5,083	126,498	60,244	26,038	11,410	163,721
Increase (+) or decrease (−)	+3	−2,320	−186,393	−60,878	−87,859	+6,955	−240,178

La Plata County in 1914 produced 5,083 tons of ore, yielding $126,498 in gold; silver, valued at $33,315; copper, at $3,463; lead, $445—a total of $163,721, as compared with $403,899 in 1913 and with $165,334 in 1912. With the exception of the output of some bullion from high-grade specimens, all the ore was shipped to smelters. The average assay per ton of ore shipped in 1914 was 1.1803 ounces or $24.89 in gold and 11.85 ounces of silver, as compared with $42.27 in gold and 16.36 ounces of silver in 1913.

California [2] *(La Plata) district.*—The mines of this district are located in the La Plata Mountains, in the drainage basin of La Plata River, the nearest town being La Plata, 10 miles from Hesperus, the shipping point on the Rio Grande Southern Railroad.

[1] For description see Becker, J. A., Colorado State Bur. Mines Thirteenth Bien. Rept., 1913–14, p. 95, 1914.

[2] For discussion of geology see Cross, Whitman, and others, U. S. Geol. Survey Geol. Atlas, La Plata folio (No. 60), 1899; Emmons, W. H., The Neglected mine and nearby properties, Colorado: U. S. Geol. Survey Bull. 260, pp. 121–127, 1905.

The May Day, Idaho, Incas, and Lucky Four mines were the principal producing gold-silver mines in 1914. Other producing mines were the Brooklyn, Bulldozer, Copper Hill, Durango Girl, Eagle Pass, Gold Dollar, Jumbo, Little Nona, Lost Chance, Morovaratz, Old Comfort, Tenbroeck, and Volcanic.

On the west slope of the west ridge of the La Plata Mountains, but in Montezuma County, are some mines and prospects from which no production was made in 1914.

Cave Basin district.—This district, from which a small yield was first made in 1913, is located in the San Juan National Forest, and advices from the United States Forest Service indicate that the mineralized area lies about 20 miles north and east of Bayfield, in La Plata County, near the La Plata-Hindsdale County line, between Vallecito and Pine rivers, approximately in secs. 1, 2, 11, and 12, T. 37 N., R. 6 W., with a center on Mount Rundlett, and extending northward into T. 38 N. The altitude is from 9,500 to 11,000 feet. The southwest corner of the San Cristobal quadrangle of the United States Geological Survey includes a portion of the district.

Two small lots of copper-lead-silver ore were shipped in 1914 from the Holbrook and Mary Murphy claims.

MESA AND MONTROSE COUNTIES.

Several cars of copper ore were shipped from the Cliff Dwellers mine, near Uranium, 11 miles from Paradox; from the Old Mexico mine, near Nucla; and from the Sunrise mine, on La Sal Creek, 6 miles from Bed Rock—all in Montrose County. Some placer gold was recovered by sluicing near Uranium, Montrose County.

In Mesa County, the Pyramid mine, in Sinbad Valley, is reported as opened by an adit 425 feet long, and by another 90 feet long, and by various open cuts, but no production was made. There is a 100-ton leaching plant on the property. In the Unaweep[1] district, the McKinley group is reported to have an incline shaft 675 feet deep. Development work was done on the Nancy Hanks mine, which is now opened by a 200-foot shaft and by a new shaft 120 feet deep. There is a 50-ton matte smelter on this property.

MINERAL COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Mineral County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	12	56,763	$50,282	805,343	31,647	3,398,364	454,875	$716,615
1914	9	27,952	19,304	615,734	32,586	1,401,795	.....	418,809
Increase (+) or decrease (−)	−3	−28,811	−30,978	−189,609	+939	−1,996,569	−454,875	−297,806

[1] For discussion of geology see Butler, B. S., Notes on the Unaweep copper district, Colorado: U. S. Geol. Survey Bull. 580, pp. 19–23, 1914.

Creede district.[1]—All the producing mines of Mineral County are included in the Creede district, except a mine situated 10 miles northwest of Creede, which has been producing since 1912.

Mineral County in 1914 produced 27,952 tons (all smelting ore), carrying $19,304 in gold; silver, valued at $340,501; copper, at $4,334; lead, $54,670—a total of $418,809, as compared with $716,615 in 1913. There were heavy decreases in all the metals.

The ore shipped averaged: Gold, 0.0334 ounce; silver, 22.03 ounces; lead, 2.51 per cent.

The producing mines at Creede were the Alpha-Nelson, Amethyst Bachelor, Commodore, Park-Regent, New York-Last Chance-Volunteer, and Holy Moses. The mills of the district were idle.

Silver-gold ore was shipped from the Equity mine, 10 miles northwest of Creede, on the Continental Divide.

MOFFAT COUNTY.

Fourmile district (near Baggs, Wyo.).—Sluicing of the bench and river gravels along Fourmile Creek recovered $4,436 in gold and 11 ounces of silver. Producing mines were the Hawkie, Nelson, Pole Gulch, and Timberlake.

MONTEZUMA COUNTY.

See California district, La Plata County.

MONTROSE COUNTY.

See Mesa and Montrose counties.

OURAY COUNTY.[2]

Mine production of gold, silver, copper, lead, and zinc in Ouray County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	31	97,336	$959,377	537,634	500,329	2,180,591	200,429	$1,468,829
1914	37	105,560	1,211,993	594,289	854,038	2,119,564	44,608	1,739,160
Increase (+) or decrease (−)	+6	+8,224	+252,616	+56,655	+353,709	−61,027	−155,821	+270,331

The total value of the output from Ouray County in 1914 was $1,739,160, of which $1,211,993 was for gold, $328,642 for silver, $113,587 for copper, $82,663 for lead, and $2,275 for zinc. This county ranked fourth in the yield of gold, and fourth in total value of output. The output of gold, silver, and copper increased, but the yield of lead and zinc decreased.

[1] For discussion of the geology of the district see Emmons, W. H., and Larsen, E. S., A preliminary report on the geology and ore deposits of Creede, Colo.: U. S. Geol. Survey Bull. 530, pp. 42–65, 1913.

[2] For discussion of geology see Cross, Whitman, and Howe, Ernest, U. S. Geol. Survey Geol. Atlas, Ouray folio (No. 153), 1907, and U. S. Geol. Survey Geol. Atlas, Silverton folio (No. 120), 1905.

The Wanakah copper matting plant was operated on crude ore from the Wanakah mine and on numerous small lots of custom ore from Ouray, Hinsdale, and Dolores counties, and at the close of the year a 200-ton addition to the smelter was nearly completed. The Huff electrostatic separation plant at Ouray was operated for a short period on lead-zinc ore and concentrates from the Barstow and Mickey Breen mines.

The tonnage of ore sold or treated increased from 97,336 tons to 105,560 tons. The average yield per ton in gold was $11.48, as against $9.86 in 1913, against $11.67 in 1912, $14.66 in 1911, $19.74 in 1910, $29.32 in 1909, and $21.02 in 1908.

In 1914, of the 105,560 tons mined, 48,991 tons were treated at amalgamation and cyanidation mills having concentration equipment, and an average of $11.99 in gold and 0.18 ounce silver per ton were recovered as bullion. From this ore sent to amalgation and cyanidation mills and from 32,033 tons sent to mills for concentration only were produced 12,496 tons of concentrates, averaging $34.23 in gold, and 33.15 ounces silver per ton, and also copper, lead, and zinc, with a total gross value of $63.90 per ton. Crude ore shipped to smelters averaged $8.03 in gold; 6.98 ounces silver per ton; and also copper, lead, and zinc, with a total average gross value of $14.21.

Red Mountain district.—Only two mines were operated in this district in 1914. The Barstow mine was operated by sublessees all the year and the mill [1] was operated in the summer only. Ore from the Saratoga mine was shipped to the Wanakah smelter.

Sneffels district.—This is the principal district in Ouray County. In 1914, from 5 mines, there were sold or treated 63,170 tons of ore, from which were recovered $822,939 in gold, 430,047 ounces of silver, 274,859 pounds of copper, and 1,826,766 pounds of lead, with a total value of $1,168,555, as compared with $1,050,720 in 1913, with $1,104,159 in 1912, and with $2,162,198 in 1911.

The tonnage increased 1,028 tons; gold increased $149,028; silver increased 31,975 ounces; copper decreased 40,219 pounds; and lead decreased 69,625 pounds.

The Atlas 20-stamp, 8-foot Hardinge pebble mill, flotation plant [2] was operated steadily with an increased output of concentrates. The Camp Bird mine produced approximately the same output of ore as in 1913, but the grade was higher. The Camp Bird public annual report for the year ended June 30, 1914, says:

An average of 25 stamps worked 347.93 days and crushed 30,595 tons of dry ore. The ore yields as follows:

Metal.	Content.	Value per ton.	Per cent of value.	Total value of output.
Gold.....ounces..	1.135	$22.91	87.49	$700,880
Silver.....do....	4.270	2.36	9.01	72,206
Lead.....per cent..	1.324	.44	1.67	13,378
Copper.....do....	.260	.48	1.83	14,615
Total.....	.....	26.19	.....	801.079

[1] For description see Wilfley, C. R., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913-14, pp. 91-93, 1914.

[2] For description of mill see Carroll, F., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913-14, p. 71, 1914.

The value in the previous year was $22.51 per ton, and the total recovery was valued at $675,630.

The cyanide plant treated 19,344 tons of tailing from the mills, and extracted $39,748. Of the recovery of the mill and plant, the processes were as follows: Amalgamation, 52.97 per cent; concentration, 42.07 per cent; and cyanidation, 4.96 per cent; the saving of gold and silver in the crude ore being 94 per cent. Costs were $1.64 in the stamp mill, $0.88 in the cyanide mill, and $3.10 per ton for bullion and concentrate charges.[1]

The general situation is no better than as advised in the report for 1913, but rather exaggerated with increasing depth and narrowing stoping widths in hard ground. Development totaled 3,605 feet. Work is confined to the territory reached through No. 3 shaft, and a vein of increasing width, with depth, throughout a length of about 500 feet, lessened at each end to a width comparing with that in the upper levels, thus forming a lenticular "bulge." At between No. 4 and 5 levels it was 12 feet wide, increasing to 30 feet 400 feet deeper, and for a short length on No. 8 it is 60 feet wide. This forms the productive area of the mine. Quartz predominates in the vein filling, and only a small percentage is profitable. The profitable ore has hematite for its base, and is freakish, as it contains iron, zinc, and lead sulphides. It occurs in streaks, lengths being less persistent and narrower with depth, and less regular in the relation to the walls. The extreme west end of the mine is leased to the Argo Mining Co., and 1,145 feet of work failed to reveal profitable ore. Ore reserves are estimated at approximately 25,709 tons, which will yield a profit of $307,648. On June 30, 1914, there was 17,616 tons of ore broken in stopes.[2] The year's profit was $337,000, of which $218,000 was paid to preference shareholders.

A small tonnage of gold-silver ore was shipped from the Bimetallic mine. Several cars of lead-silver ore were shipped from the Revenue mine. Lead ore from the Cumberland mine was milled at the Revenue mill and lead concentrates were shipped at smelter and a considerable quantity of lead ore was sent direct to smelter without milling.

Uncompahgre district.—The Uncompahgre district, from 30 mines, in 1914 produced 40,241 tons, yielding $353,823 in gold, 154,362 ounces of silver, 563,631 pounds of copper, 160,589 pounds of lead, and 14,962 pounds of zinc, with a total value of $521,174, as against $317,942 in 1913, $309,434 in 1912, and $187,802 in 1911. Over half the ore was sent to smelters, the rest being sent to amalgamation-concentration mills.

The Bright Diamond-Iron Clad group, operated by the Wanakah Co., was the principal producing property. A large tonnage of pyritic (with some chalcopyrite) gold-silver ore was sent direct to the Wanakah copper matting plant. A large tonnage was also sent to the company's 20-stamp amalgamation-concentration mill, the bullion being sent to the mint, and gold-silver (with some copper) concentrates shipped to Salida.

Ore from the American Nettie mine and from the O. & N. dump were milled in a 3½-foot Huntington mill, with amalgamation, and a Wilfley table, and concentrates were shipped to Salida. Several cars of ore were also shipped to Salida. Gold-silver sulphide ore from the Angel mine was shipped to the Wanakah smelter; lead ore from the Bachelor-Khedive, from the Benack, from the El Mahdi, and from the Wewissa was shipped to lead plants; silver-lead-copper ore to lead plants; and silver-copper ore to the Wanakah smelter from the Black Girl and the Wedge mines. Other producing mines of importance were the Great Western, Mickey Breen, Jonathan, Newsboy, Oregon-Galena, Senorita, Speedwell, Syracuse, and Yorktown.

[1] Min. and Sci. Press, October 31, 1914, p. 689.

[2] Min. and Sci. Press, November 14, 1914, p. 782. See also Min. Mag. (London), pp. 287–288, and p. 19, adv. section, November, 1914, and Eng. and Min. Jour. Feb. 20, 1915, p. 371.

PARK COUNTY.[1]

Mine production of gold, silver, copper, lead, and zinc in Park County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	25	6,598	$50,041	94,293	29,161	506,046	98,623	$139,303
1914	15	1,958	67,485	20,215	8,023	168,154	57,940	89,244
Increase (−) or decrease (+)	−10	−4,640	+17,444	−74,078	−21,138	−337,892	−40,683	−50,059

[a] Includes placer production.

The value of the metallic output of Park County in 1914 was $89,244, of which $67,485 was for gold, $11,179 for silver, $1,067 for copper, $6,558 for lead, and $2,955 for zinc. There were 13 producing deep mines and 2 placers, as against 21 deep mines and 4 placers in 1913. The placer yield was $23,334 in gold and 206 ounces of silver in 1914, as against $14,758 in gold and 139 ounces of silver in 1913.

Beaver district.—Placer mines in this district were idle.

Buckskin district.—The Buckskin district, which in 1913 produced 1,236 tons, which yielded $5,772 in gold, 1,514 ounces of silver, 2,525 pounds of copper, 87,787 pounds of lead, and 59,056 pounds of zinc, with a total value of $14,247, made only a small yield in 1914, the result of the operation of the Paris amalgamation mill for several months.

Consolidated Montgomery district.—From 323 tons shipped to smelters and a small quantity of bullion from specimens, the yield was $7,167 in gold, 5,933 ounces of silver, 2,428 pounds of copper, and 8,381 pounds of lead, with a total value of $11,098, as against $9,649 in 1913. Producing mines were the Anna, Atlantic and Pacific, Creskill, Dolly Varden, Galveston, Magnolia, Our Fritz, and Sweet Home.

Freshwater district (Guffey).—No output was made from this district.

Hall's district.—No output was made from this district.

Horseshoe district.—Lead-silver ore and zinc carbonate ore was shipped from the Chance-Hill Top mine. An increased yield was made from the Snowstorm placers.

Mosquito district.—An increased quantity of ore, carrying a very appreciable content of gold was shipped from the London mine,[2] at the head of Mosquito Creek, on the ridge between Leadville and Alma. Small shipments were made from the Golden Wave, Kennebec, and Good Samaritan mines.

Pulver (or Lake George) district.—The Great Western property is opened by a 218-foot vertical shaft and an 120-foot incline shaft and 800 feet of crosscuts and drifts. During 1914 development work was

[1] For discussion of geology see Patton, Horace B., Hoskin, Arthur J., Butler, G. Montague, Geology, and ore deposits of the Alma district, Park County, Colo.: Colorado State Geol. Survey Bull. 3, 1912.

[2] For discussion of geology see Moore, C. J., The London mine, Mosquito district, Colorado: Am. Inst. Eng. Bull. 75, pp. 415–427, March, 1913.

continued for part of the year and small shipments of zinc sulphide and lead-silver ore were made for testing the results of concentration.

Tarryall district.—An increased quantity of bullion was recovered from the Fortune placer by hydraulicking.

PITKIN COUNTY.[1]

Mine production of gold, silver, copper, lead, and zinc in Pitkin County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	13	114,264	$29	562,308	48,852	17,528,386	460,161	$1,144,253
1914	13	118,000	423	372,886	67,737	23,233,230	145,431	1,129,151
Increase (+) or decrease (−)		+3,736	+394	−189,422	+18,885	+5,704,844	−314,730	−15,102

Pitkin County in 1914 produced 118,000 tons of ore, with a total gross value of $1,129,151, of which $423 was for gold, $206,206 for silver, $9,009 for copper, $906,096 for lead, and $7,417 for zinc. The silver yield decreased 189,422 ounces, and the lead yield increased 5,704,844 pounds. A considerable quantity of zinc carbonate (with seams of galena) ore was shipped. The ore sent to mills increased with a corresponding increase in concentrates; but the smelting ore decreased slightly. The average recovered content of the ore sold or treated (deducting the zinc ore) was 3.16 ounces of silver and 9.85 per cent of lead. The zinc ore was shipped from the Durant mine.

Aspen (Roaring Fork) district.—At Aspen are located all the large producing mines in Pitkin County. The Smuggler was the principal producing mine. A large quantity of ore was sent to the Smuggler 360-ton concentrating mill [2] and a large quantity direct to smelters. Other producing mines were the Argentum-Juniata, Aspen, Della S., Durant, Millince, and Spar Consolidated mines.

Ashcroft (or Columbia) district.—No work was done in this district in 1914.

RIO GRANDE COUNTY.

Summitville district.[3]—A small shipment of gold-silver ore was made from this district.

ROUTT COUNTY.[4]

Hahns Peak district.—A small quantity of placer gold was produced in 1914. Development work was continued on the Royal Flush group, the total footage being 9,133 feet, of which 722 feet was driven in

[1] For discussion of geology see Spurr, J. E., Geology of the Aspen mining district, Colorado, with atlas: U. S. Geol. Survey Mon. 31, 260 pp., 1898.

[2] For description of mill see Anderson, C. E., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 104–105, 1914.

[3] See Conejos County.

[4] For discussion of geology see George, R. D., and Crawford, R. D., The Hahns Peak region, Routt County, Colo.: Colorado Geol. Survey First Rept. for 1908, pp. 189–229, 1909. Gale, H. S., The Hahns Peak gold field: U. S. Geol. Survey Bull. 285, pp. 28–34, 1906; Gold placer deposits near Lay, Routt County, Colo.: U. S. Geol. Survey Bull. 340, pp. 84–95, 1908.

1914. Work on the construction of the 400-ton concentration mill was continued.

Slater district.—Assessment work was done on the mines near Slater.

Yarmony district.—The Copper King claim is opened by a 400-foot incline shaft.

SAGUACHE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Saguache County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	10	980	$4,243	8,694	13,277	336,886	32,964	$28,221
1914	8	1,488	16,513	18,293	35,783	534,872	8,941	52,704
Increase (+) or decrease (−)	−2	+508	+12,270	+9,599	+22,506	+197,986	−24,023	+24,483

Saguache County in 1914 produced 1,488 tons of ore, with a gross value of $52,704, of which $16,513 was for gold, $10,116 for silver, $4,759 for copper, $20,860 for lead, and $456 for zinc.

Baca Grant (Crestone) district.—A small lot of ore was shipped from the Pelican mine.

Cochetopa district.—A small shipment of copper ore was made from the Yukon mine.

Kerber Creek (Bonanza) district.—There was a considerably increased output from this district, the principal producing district in the county. Lead sulphide ore was shipped from the Antoro and from the St. Louis mines; copper, copper-lead, and lead-zinc ore from the Bonanza mine. Assessment work was done on the Rawley mine.

SAN JUAN COUNTY.[1]

Mine production of gold, silver, copper, lead, and zinc in San Juan County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	38	123,343	$657,612	880,409	1,221,516	9,508,979	1,664,999	$1,890,349
1914	29	117,988	508,477	493,917	825,180	5,199,000	971,177	1,143,653
Increase (+) or decrease (−)	−9	−5,355	−149,135	−386,492	−396,336	−4,309,979	−693,822	−746,696

San Juan County in 1914 produced 117,988 tons of ore, with a gross value of $1,143,653, of which $508,477 was for gold, $273,136 for silver, $109,749 for copper, $202,761 for lead, and $49,530 for zinc.

[1] For discussion of geology see Cross, Whitman, Howe, Ernest, and Ransome, F. L., U. S. Geol. Survey Geol. Atlas, Silverton folio (No. 120), 1905.

During 1914 there were treated at amalgamation and cyanidation mills 55,700 tons of ore, with an average recovery per ton in bullion of $2.25 in gold and 0.05 ounce silver; there were also 57,613 tons sent to mills for concentration only, a total of 113,313 tons (96 per cent of all the ore mined), which yielded 16,337 tons of concentrates, averaging $19.44 a ton in gold, 17.93 ounces of silver, and also copper, lead, and zinc, with a total gross value per ton of $47.12.

Crude ore shipped to smelters—4,675 tons—averaged $14.07 in gold, 42.42 ounces silver, 1.71 per cent copper, and 13.36 per cent lead.

Animas district (including the mines in the immediate vicinity of Silverton and south and east of Animas River from Silverton to Middleton).—The Animas district in 1914 produced 36,907 tons of ore, yielding $206,630 in gold, 367,879 ounces of silver, 510,524 pounds of copper, and 3,692,483 pounds of lead, with a total value of $621,974, as compared with $915,208 in 1913.

There were 20 producing mines in 1914, as against 26 in 1913. The principal producing mines in the district were the Silver Lake mines and the Iowa-Gold Tiger group. The Silver Lake mines were operated by lessees throughout the year. The 300-ton concentration mill was opened as a custom plant in May. A 100-ton froth flotation unit was added to the mill. The ore is sulphide in quartz gangue, although some of the ore is partly oxidized. Lead and copper concentrates and crude lead ore were shipped to the Durango smelter. Mears & Wilfley built a mill to treat the tailings of previous years and operated it for a period. Oxidized and heavy lead sulphides from the Aspen mine were shipped to the Durango smelter; low-grade sulphides were shipped to the Silver Lake custom mill. Lead sulphide ore of the Iowa-Tiger mine was milled at the company's mill, the product being lead-copper-silver-gold concentrates. Lead ore from the Dives and the Highland Mary mines was shipped to Durango. Ore from the Intersection mine was treated by amalgamation and concentration. Other producing mines were the Anti-Periodic, Bonner, Hercules, Kansas City, Little Mary, Mayflower, North Star, Pride of the West, and Shenandoah.

Eureka district (north of Silverton, including Chattanooga, Gladstone, Animas Forks, and Eureka).—This district in 1914 produced 81,081 short tons of ore, yielding $301,847 in gold, 126,038 ounces of silver, 314,656 pounds of copper, 1,506,517 pounds of lead, and 971,177 pounds of zinc, with a total value of $521,679, against $975,141 in 1913. There were 9 producing mines in 1914, against 12 in 1913. A large quantity of ore was milled at the Sunnyside mill by amalgamation, concentration, and electrostatic separation, the product being bullion, lead concentrate, and zinc concentrate. A large quantity was treated at the Gold King concentration mill, to which the flotation process was added for treatment of slimes. Lead-zinc sulphide ore from the Frisco tunnel was mined by lessees and milled at the company's concentration plant, which was operated for a few months. The product was lead concentrates and lead-zinc concentrates, the tailings being impounded for future treatment. Copper ore was shipped from the Congress mine and from the Sultana mine. Other producing mines were the Esmeralda, Joe and John, Poughkeepsie, and Red Cloud.

SAN MIGUEL COUNTY.[1]

Mine production of gold, silver, copper, lead, and zinc in San Miguel County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	27	509,175	$2,129,371	1,051,096	736,374	6,967,136	2,405,750	$3,319,647
1914	25	495,742	2,114,916	1,280,461	324,105	4,039,769	.....	3,023,668
Increase (+) or decrease (−).	−2	−13,433	−14,455	+229,365	−412,269	−2,927,367	−2,405,750	−295,979

The value of the metallic production of San Miguel County in 1914 was $3,023,668, of which $2,114,916 was for gold, $708,095 for silver, $43,106 for copper, and $157,551 for lead.

In gold yield, San Miguel maintained its place as second to Teller, and in silver, held second place after Lake County. In total gross value of metals produced San Miguel stood third, with Teller first, Lake second, and Ouray fourth.

During 1914, of the 495,742 tons mined, there were treated at amalgamation and cyanidation mills, most of which also had concentration equipment, 476,240 tons of ore, or 96 per cent of all the ore mined; and an average of $2.98 in gold and 1.26 ounces silver per ton was saved as bullion or as cyanide precipitates. The gold saved as bullion in 1914 represented 67 per cent of the gold produced in the county, and the silver in bullion represented 47 per cent of the county silver output.

There were 19,901 tons of ore sent to mills for concentration only, making a total of 495,331 tons milled (99.92 per cent of all the ore mined), which yielded 26,576 tons of concentrates, averaging $26.04 in gold and 25.16 ounces of silver per ton, and 0.61 per cent of copper and 7.40 per cent of lead, with a total gross value of $47.34, as compared with $55.51 in 1913.

Crude ore sent to smelters—411 tons—averaged $5.895 in gold and 32.82 ounces of silver per ton, and 0.30 per cent copper and 12.85 per cent lead.

Upper San Miguel district.—The Upper San Miguel district in 1914 produced 472,444 tons of ore, yielding $2,051,271 in gold, 1,261,611 ounces of silver, 321,607 pounds of copper, and 3,929,613 pounds of lead, with a total gross value of $2,944,971, as compared with $3,176,129 in 1913. Three large companies, the Liberty Bell, the Smuggler Union, and the Tomboy, furnished over 90 per cent of the total output.

The annual report for the Tomboy Gold Mines Co. (Ltd.) for the year ending June 30, 1914, states:

> At the Argentine claims, development was limited to the south end of the mine near manway 119 on the 2,100-foot level. At 60 feet above the level a drift opened 3 feet of ore containing considerable lead and zinc, but only $3 to $4 per ton in gold and silver. The winze from this level, started in 1911, is down to 2,200 feet, and the vein

[1] For discussion of geology see Purington, C. W., Preliminary report on the mining industries of the Telluride quadrangle, Colo.: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, pp. 745–850, 1898. Cross, Whitman, and Purington, C. W., U. S. Geol. Survey Geol. Atlas, Telluride folio (No. 57), 1899. Hess, F. L., Notes on the vanadium deposits near Placerville, Colo.: U. S. Geol. Survey Bull. 530, pp. 142–156, 1912.

is being opened. So far it is about the same value as at 2,100 feet. Owing to a cave-in in the upper portion of the mine, it was necessary to draw all ore above the 500-foot level in one area, while the remainder of the stopes above 500 feet will be drawn during the current year. Pillars of ore supporting the level will be mined and dropped to 650-foot level stopes. Reserves in the Argentine mine amount to 215,000 tons, of which 190,000 tons is broken in stopes. In the Montana mine, reserves are estimated at 237,000 tons, 137,000 tons being in stopes. Development in this area during the year was 4,816 feet. Work at 1,450 feet and the Fortuna level has shown a shoot totaling 2,500 feet in length. Ventilation of the mine has been improved greatly. The aerial tramway worked successfully, only being interrupted by a snowslide which wrecked the Midway tension station and two towers below it. The profit was $40,000, and adding that of the last five months of the previous financial year, the total was $59,000, or $8,000 over the cost of erection.

Ore sent to the mill consisted of 80 per cent Montana and 20 per cent Argentine product, against 41 and 59 per cent, respectively, last year. There was a decrease in concentrate output, as the Montana ore contains less sulphides. This eliminated recovery of zinc middling as a concentrate product, and consequently experiments with flotation and electrostatic processes were abandoned. As the result of tests * * * Tomboy ores were proved to be amenable to cyanidation. A 400-ton plant was planned, and in the middle of August, 1914, erection of the building was well underway. The mill treated 137,456 tons of ore yielding bullion worth $385,612, and concentrate valued at $573,447.[1]

The profit on the ore, excluding depreciation and other receipts, London expense, income tax, etc., was $354,682 from 137,456 tons yielding $6.98 per ton. The operating cost was $4.40 per ton, made up of mining, $1.71; development, $0.79; milling, $0.54; concentrating, including transporting ore to railroad, $0.73; water supply, $0.13; assay office, $0.04; general expense, $0.24; taxes and insurance, $0.22 per ton. Adding depreciation and other expenses deducted by the London office the total cost was $4.48 per ton.[2]

The Tomboy 60-stamp 400-ton amalgamation-concentration mill was operated continuously during the year. The new 400-ton cyanide plant, to treat tailings, was completed and was operated for 21 days in December, 1914.

The 80-stamp 500-ton cyanidation and concentration mill of the Liberty Bell Co. was operated continuously. (Amalgamation was discontinued May, 1914.) The ore is crushed in cyanide solution, agitated, and values are recovered by filtration. The concentrate made is roughly cyanided and concentrate residues are shipped to smelter.

The annual report of the Liberty Bell Gold Mining Co. for the year ended September 30, 1913, states:

	1913	1912	1899–1913
RECEIPTS PER TON OF ORE MILLED.			
Stamp bullion	$2.25	$3.22	$3.87
Cyanide products	2.18	2.77	2.24
Concentrates	.56	.88	.82
Concentrates cyanide bullion	.25	.....	.03
Slag	.....	.....	.01
Total ore proceeds	5.24	6.87	6.97
Miscellaneous profits	.20	.22	.17
Total proceeds	5.44	7.09	7.17
EXPENSES PER TON OF ORE.			
General (per ton milled)	.50	.61	.72
Mining (per ton mined):			
Operating	1.43	1.68	2.39
Development work	.26	.17	.07
Tramming	.16	.16	.29
Milling	1.41	1.47	1.63
Treatment and shipment costs	.19	.28	.22
Average cost on basis of tons milled	3.95	4.37	5.32
Profit per ton milled	1.49	2.72	1.82

[1] Min. and Sci. Press, Oct. 31, 1914, p. 706.
[2] Eng. and Min. Jour., Jan. 23, 1915, p. 198. See also Min. Mag. (London), October, 1914, p. 272; Min. and Eng. World, Oct. 24, 1914, p. 766.

During 1913, details of shipment and treatment costs were as follows: On stamp bullion, 3 cents per ounce of gold; on concentrates, $15.10 per ton of concentrates; on cyanide bullion, 2 cents per ounce; and on cyanide bullion from concentrate treatment, 3 cents per ounce of bullion. In mining 179,178 tons of ore, 355 boxes of candles were consumed, and 310 tons of coal were used for heating. Some of the principal supplies consumed in milling follow: Quicksilver, 0.125 ounce per ton of ore; 0.985 pound of cyanide; 0.526 pound of zinc; 8.1 pounds of lime; and 0.312 pound of lead acetate and litharge per ton of ore milled. In mining 179,178 tons and running 5,662 feet of development work 148,200 pounds of powder was used.

It is stated that the amount of powder consumed was due in part to the amount of drifting done and in part to the method of doing it. A bonus system of payment substituted for the older contract system led to an unusual consumption of explosives, but it was made up in the saving of labor. The net results, however, were not good and the contract system was resumed. The width of the vein in the area mined was 5.4 feet against 4.6 feet for the previous year. The average width of the vein to date including pinched portions is 3 feet. The Liberty Bell has produced 1,397,168 tons of ore to date and performed 59,799 feet of development work or about 1 foot for every 23.4 tons of ore produced. Including ore in sight the ratio is 35 tons per foot of development. Counting all possible ore within the property above the Stilwell Tunnel, development work equals about 1 foot for 50 tons of ore. The total ore proceeds to date amount to $9,727,012, and expenses, after deducting miscellaneous receipts, $7,217,296. Profit balances amount to $2,509,716, but of this amount $360,486 for construction still stands on the books to be charged out. The total expenditure to date for construction is $712,042, or about 51 cents per ton of ore produced. The ratio of concentration is 65 : 1 and has averaged 64 : 1 to date.[1]

The Smuggler Union mines and 140-stamp, 500-ton amalgamation, concentration, and cyanidation mills [2] were operated steadily.

The 300-ton amalgamation and cyanidation plant of the Junta Consolidated Co. was operated one month and the mine three months of 1914. The Alta mine and concentration mill were operated 11 months of the year. The Ballard 10-stamp amalgamation and concentration mill was operated for nine months.

Iron Springs (Ames and Ophir) district.—The Iron Springs district in 1914 produced 23,253 tons of ore, yielding $62,452 in gold, 17,878 ounces of silver, 2,033 pounds of copper, and 78,947 pounds of lead, with a total value of $75,688, as compared with $135,095 in 1913.

There were 9 producing mines in the district. The Butterfly-Terrible mine and mill were operated the greater part of the year. Bullion was the product from the treatment of the ore from the Charter Oak mine. The Ophir Gold Mines Co.'s cyanidation mill [3] was operated for a period. Lead-silver ore was shipped to smelter from the Carbonero and Carribeau mines.

Lower San Miguel (Sawpit and Placerville) district.—Bullion was marketed from the treatment of ore from the Gertrude mine.

Mount Wilson district.—A small quantity of bullion was marketed for treatment of ore from the Link mine and several cars of lead ore were shipped from the Morning Star mine.

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[1] Eng. and Min. Jour., p. 198, Jan. 23, 1915. See also Chase, Charles A., Notes on the Liberty Bell mine: Am. Inst. Min. Eng. Bull. 60, pp. 981–1028, December, 1911. For description of mill see Tracy, W. E., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 102–103, 1914.

[2] For description see Wells, Bulkeley, Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 98–99, 1914.

[3] For description of process see Parmelee, H. C., Cyaniding slimy ore by continuous decantation: Metall. and Chem. Eng., January, 1913, pp. 25–28; see also Min. Mag. (London), February, 1913, p. 144.

SUMMIT COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Summit County, Colo., in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold.		Silver.[a]	Copper.	Lead.	Zinc.	Total value.
			Placers.	Deep.					
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913.....	45	40,360	$386,196	$76,032	167,490	18,170	3,944,268	6,931,074	$1,127,896
1914.....	51	22,199	608,567	60,043	67,009	7,339	1,565,231	5,111,941	1,028,395
Increase (+) or decrease (−).....	+ 6	−18,161	+222,371	−15,989	−100,481	−10,831	−2,379,037	−1,819,133	− 99,501

[a] Includes placer production.

Summit County deep mines in 1914 produced 22,199 tons of ore, yielding $60,043 in gold; silver valued at $33,175; copper, at $976; lead, at $61,044; and zinc, at $260,709—a total of $415,947, as compared with $739,055 in 1913. Dredges[1] and other placer operations yielded $608,567 in gold and 7,018 ounces of silver, valued at $3,881, a total of $612,448, against $386,196 in gold and 4,379 ounces of silver, valued at $2,645, a total of $388,841, in 1913.

Summit County is the principal placer producing county in Colorado, but in production of zinc in 1914 it fell to third place after Eagle County.

Breckenridge district.[2]—The Breckenridge district includes the Bevan, Minnesota, and Union districts and contains the mines near Breckenridge, on French Gulch and on Blue and Swan rivers and all the placers in the county. The value of the total output of gold, silver, copper, lead, and zinc from both deep and placer mines was $982,329, or 95.5 per cent of the county yield, and a decrease for 1914 of $36,136, as compared with the yield in 1913, but an increase of $117,198 as compared with the yield of 1912.

The principal producing mine is the Wellington mine. In 1914 the mine was operated on ore production only six months and on development six months. The 100-ton wet-concentration mill was operated six months and the roasting and magnetic separation mill[3] was operated 10 months.

The Laurium (or Blue Flag) mine and mill were operated for six months. Lead-silver ore was shipped from the Brooks Snyder mine, and lead-zinc ore from the Bullion King. Lead-ore and dry gold-silver ore from the Dunkin mine were shipped to smelter, and a considerable quantity of metallic gold was recovered from pockets and sent to the mint. Lead ore from the Extension, Gold Dirt, Gold Dust, Lucky, Mountain Gem, and Juniata; zinc ore from the Country Boy; gold-

[1] See Revett, B. S., Gold dredging: Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 128–131, 1914.

[2] For discussion of the geology of the district see Ransome, F. L., Geology and ore deposits of the Breckenridge district, Colorado: U. S. Geol. Survey Prof. Paper 75, 1911.

[3] For description of magnetic plant see Parmelee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., September, 1912, pp. 525–528. Also for description of mills see Henderson, R. M., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 106–110, 1914.

silver ore from the Montana and the Standard; and lead-zinc and gold-silver ore from the Jessie was sent to smelter. A quantity of iron-lead sand accummulated from the sluices was shipped by the French Gulch Dredging Co.

All four of the dredges in the district were operated in 1914, with a heavily increased yield. The Tonopah Placers Co., which took over the Reliance dredge and the two dredges of the Colorado Gold Dredging Co., operated three dredges. The Reliance dredge is of the double-lift, open-connected type, with buckets of a capacity of 9 cubic feet. The two other dredges are of the Bucyrus open-connected type, with buckets of a capacity of 9½ cubic feet.

The report of the Tonopah Placers Co. appears in the annual statement of the Tonopah Mining Co. of Nevada:

> From 2,995,256 cubic yards of gravel dredged there was recovered 22,542 ounces gold and 4,782 ounces silver. The average value was $0.155 per yard. The profit was $0.096 per yard. Gross value of bullion was $467,294. The net income was $176,677. Adding to the previous surplus the total on February 28, 1915, was $269,580, * * * There remain 4,836 acres to be dredged.[1]

The French Gulch Dredging Co. or Reiling dredge (Bucyrus type), was operated steadily. The Bemrose, French Creek, Sisler, and Mekka placers were operated by hydraulicking and sluicing.

Consolidated Tenmile[2] *district (Frisco, Kokomo, and Robinson).*—This district in 1914, from 11 mines, produced 663 tons of ore, yielding $2,155 in gold, 4,866 ounces of silver, 625 pounds of copper, 85,729 pounds of lead, and 105,673 pounds of zinc, with a total value of $13,661, as compared with $73,999 in 1913. The Robinson mine and magnetic separator and the wet concentration mill[3] were idle.

A car of zinc sulphide ore was shipped from the Free America mine; lead ore and lead-zinc sulphide ore from the Boston group; siliceous silver ore from the Queen of the West; lead ore from the Result; zinc ore from the Raven; and lead ore from the Summit M. & S. Co.'s property.

Montezuma district.[4]—This district in 1914, from 6 mines, produced 1,909 tons, yielding $294 in gold, 17,063 ounces of silver, 4,090 pounds of copper, 286,759 pounds of lead, and 214,648 pounds of zinc, with a total value of $32,405.

The Bolivar mine and 50-ton wet concentration mill were operated for three months, the product being zinc concentrate. From the Bessie Cora mine lead ore was shipped to lead smelters and lead-zinc ore to Sutton, Steele & Steele. Lead-zinc ore from the Philadelphia mine was treated at the Philadelphia concentration mill, lead and zinc concentrates being shipped. Lead ore from the Shoe Basin and Prussian mine was shipped to lead smelters or concentrated at the Philadelphia mill. From the St. John mine lead ore was shipped to lead smelters and lead-zinc ore to the Pringrey concentration and froth flotation plant at Leadville. A shipment of lead ore was made from the New Pennsylvania mine.

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[1] Min. and Sci. Press, May 22, 1915, p. 813.

[2] For discussion of geology see Emmons, S. F., U. S. Geol. Survey Geol. Atlas, Tenmile district folio (No. 48), 1898.

[3] For description of mill see Parmelee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., February, 1911, pp. 91–96.

[4] For discussion of geology see Patton, H. B., The Montezuma mining district of Summit County, Colo.: Colorado Geol. Survey First Rept., 1908, pp. 104–144, 1909.

TELLER COUNTY.

Mine production of the Cripple Creek district, Colorado, in 1913 and 1914.

Year.	Number of producing mines.	Ore.	Gold, value.	Silver.		Total value.
				Quantity.	Value.	
		Short tons.		*Fine ozs.*		
1913	77	917,406	$10,905,003	71,349	$43,095	$10,948,098
1914	80	939,423	11,996,116	89,056	49,248	12,045,364
Increase (+)	+ 3	+ 22,017	+1,091,113	+17,707	+ 6,153	+1,097,266

CRIPPLE CREEK DISTRICT.[1]

In 1914 there were recovered in the Cripple Creek district by mills and smelters from crude ore and dump ore, from slags, slimes, and "clean-ups" of mills, and from stolen bullion and ore, 580,312.11 fine ounces of gold, valued at $11,996,116, as compared with $10,905,003 in 1913, an increase for 1914 of $1,091,113.

THE CRIPPLE CREEK DRAINAGE OR ROOSEVELT TUNNEL.

The Roosevelt tunnel continued to lower the water in the mines. The recession of water at the Elkton mine was 99.3 feet in 1914. Owing to the new extension of the drainage tunnel, the recession of the water in the Portland mine was about 30 per cent more than in 1913, thus permitting mining operations under normal conditions on the seventeenth level. If the present rate of drainage continues, it will allow the sinking of the Portland shaft to the eighteenth level the latter part of 1915. The Vindicator and Golden Cycle mines, not benefited by the drainage tunnel, continued to raise the water from both properties by electric pumps at the Golden Cycle.

THE EXTENSION OF THE DRAINAGE TUNNEL.[2]

The report of the engineer for the Roosevelt drainage tunnel says in part:

The extension of the Roosevelt drainage tunnel is one of the important mining events of the present year. * * * A considerable amount of preliminary work was necessary before the actual work of tunneling could be started. The tunnel company was reorganized and a new executive committee was appointed. Subscriptions for the work were obtained from the various mine owners interested and engineers' reports and estimates of the cost of the work were secured. It was at first intended to extend the tunnel to the Elkton mine, a distance of about 2,700 feet, but the subscriptions were so substantial that it was decided to drive it to the Vindicator and Golden Cycle mines, a distance of about 10,250 feet. * * * When the work on the original tunnel was stopped in March, 1912, all pipe, track, and ventilating apparatus was taken out. These had to be replaced and about 1,100 feet of water ditch had to be cut in the tunnel before the work of actual driving could be commenced. This, with other preliminary work, required about three months.

Drilling was commenced in the heading on August 3. It was deemed advisable to make a detour to the north of the tunnel line to avoid a bad cave in the breast of the original tunnel. This detour was commenced about 55 feet back from the breast and

[1] For discussion of geology, see Lindgren, Waldemar, and Ransome, F. L., Geology and ore deposits of the Cripple Creek district, Colorado: U. S. Geol. Survey Prof. Paper 54, 1906.

[2] Arthur, E. P., jr., Drainage plans for eastern rim of the Cripple Creek contact: Min. Sci., May, 1915, pp. 38–41.

run in a northeasterly direction for a short distance and thence back to the line of the original tunnel. Some bad ground was encountered soon after the commencement of the work, and considerable heavy timbering had to be done. Toward the last of September the bad ground was passed and good progress was made until the 4th of November, when the El Paso plant was completely destroyed by fire and the work in the tunnel stopped. At the time of the fire the heading had been advanced 270 feet beyond the breast of the original tunnel, but on account of the detour 330 feet of actual tunneling had been done. On March 2, 1915, when the new El Paso plant was ready for hoisting, work on the tunnel was resumed and is now progressing satisfactorily. * * * The tunnel is being run 7 feet high and 8 feet wide in the clear, with a ditch 4 feet wide and 2 feet deep on the right-hand side of the track. The grade is three-tenths of 1 per cent, or 3 feet in 1,000 feet.

* * * The course of the original tunnel is N. 44° 20′ E. from the portal to the El Paso shaft, thence N. 74° 23′ E. to the breast. The extension is being run on the same course. On March 2, 1915, the tunnel was 17,127 feet long, practically 3¼ miles. The breast of the tunnel is now close to the west line of the Beacon and Raven property and is running toward the Elkton shaft. This shaft is about 2,400 feet from the present breast. From the Elkton the line of the tunnel runs toward the center of the Last Dollar claim, and thence to the Vindicator and Golden Cycle property. The Cresson shaft is about 900 feet north of the tunnel line and the Portland shafts a somewhat greater distance to the south.

The drainage tunnel has already done a large amount of good in unwatering the mines. The completion of the bore hole from the bottom of the El Paso shaft to the tunnel level in November, 1910, marked the commencement of the unwatering of the mines by the Roosevelt tunnel. Since then the recession of the water level in the district has been very great. Mines which have had the opportunity to observe report the recession in that time from 375 feet to more than 500 feet. * * * The extension of the work on the tunnel will still further facilitate the draining of the mines, as the tunnel is now passing through a formation cut by a number of veins and watercourses. Since starting work on the extension of the tunnel several watercourses have been cut and a corresponding increase in the water flow noted. The following table shows the water flow from July 1, 1914, to March 1, 1915:

	Gallons per minute.		Gallons per minute.
July 1, 1914	7,300	Oct. 9, 1914	9,723
Aug. 1, 1914	7,600	Nov. 1, 1914	9,861
Aug. 21, 1914	9,438	Feb. 1, 1915	8,564
Sept. 1, 1914	9,712	Mar. 1, 1915	8,213
Oct. 1, 1914	9,133		

The above table shows an increase from July 1 to November 1 of over 2,500 gallons per minute. This is partly due to some new water opened up in the stope on the C. K. and N. vein, worked through the Fuller crosscut on the tunnel level, and partly due to new watercourses cut in the heading. The measurement on March 1, 1915, shows a decrease from November 1, 1914, of 1,648 gallons per minute. This was due to no work being done on the tunnel during that time. When watercourses are cut in the tunnel, the flow increases quickly, and then decreases slowly until new watercourses are cut. At the time of the El Paso fire the measuring weir at the portal of the tunnel was blown out in order to get the men out of the mine, and it was not rebuilt until January, 1915, and no measurement was made until February 1, 1915. The new weir is equipped with gates whereby the water can be lowered and the men and mules can get out in case of accident without harm to the weir.

The tunnel in its onward course will cut the contact of the granite with the eruptive breccia in about 500 or 600 feet. The breccia forms the main part of the ore-bearing portion of the Cripple Creek district. It is expected that when this is cut there will be a heavy increase in the flow of water, and that the recession of the water level will be more rapid from that time on. Immediately previous to the El Paso fire the water level appeared to be receding faster than before, but the work was stopped before anything definite could be determined. The next few months will probably show an increase in the rate of the lowering of the water level. So far the tunnel has apparently had but little effect on the water in the Golden Cycle and Vindicator mines. It is the opinion of a number of mining men and geologists that there is a mass or dike of impervious rock running through the country between the Portland and the Golden Cycle, and that this will have to be penetrated before the latter will be relieved.

At present the Roosevelt tunnel is attracting considerable attention as a means of prospecting the deeper levels. Up to the time that the tunnel passed the El Paso it

had been in massive granite with very few veins in it. The tunnel is now passing through a country that abounds in veins and that has produced considerable ore near the surface. The discovery of large bodies of good ore in the deeper levels of the Golden Cycle, Vindicator, Portland, Cresson and other mines during the past two years has caused an appreciation of the prospecting possibilities of the Roosevelt tunnel. As the tunnel progresses it will cut a number of well-known veins at a considerable depth, and it is a matter of interesting conjecture as to what will be disclosed. The following table showing the depths below the collars of the various shafts that the tunnel will penetrate gives a good idea of the value of the tunnel for deep prospecting purposes:

	Feet.		Feet.
El Paso	1,289	Elkton	1,645
Vindicator No. 1	2,100	Findley	2,295
Golden Cycle	1,955	Last Dollar	2,175
Blue Bird	2,300	Cresson	1,925
Portland No. 2	2,145	American Eagles	2,645

Up to the present time no commercial ore has been found on the tunnel level, except that opened up on the C. K. and N. vein by the El Paso people through the Fuller crosscut. Of the veins recently cut by the tunnel, none have shown pay values, but a little drifting on any of them might disclose good ore. It is the policy of the tunnel company to take leases on the properties passed through up to a distance of several hundred feet above the tunnel level. On account of the privileges enjoyed by the tunnel company these leases can be operated advantageously either directly or through the medium of subleases.

MILLS AT COLORADO CITY.

Over 96 per cent of the original crude ore from Cripple Creek is treated at mills in the district or at custom mills near Colorado City, the remainder of the crude ore and some concentrates, part of the cyanide precipitates, slags, and "clean-up" material, going to smelters. The contents of ore, concentrates, slags, and "clean-up" material sent to smelters represent 16 per cent of the total gold output and 53 per cent of the total silver yield of the district.

The valley mills adjoining Colorado City are the Golden Cycle, a roast-cyanide (with subsidiary amalgamation) plant [1] of 1,200 tons daily capacity; the Portland, a 400-ton roast-cyanide concentration mill; and the Standard, a chlorination-concentration plant with cyanide annex. The Standard plant was idle in 1914.

At Florence, Fremont County, the tailings of the old Union chlorination plant have been treated from 1911 to 1913 in a 500-ton cyanide plant, built in 1911 by the United States Reduction & Refining Co. In 1914 this Florence plant was idle and part of the machinery was placed in a mill to treat the dump of the old Metallic Extraction Co. This new plant was operated for a short period.

MILLS IN THE CRIPPLE CREEK DISTRICT.

The Stratton's Independence mill,[2] at Victor, started in April, 1909, with a capacity of 4,500 tons per month, was enlarged to treat 7,000 tons in December of that year, and in November, 1910, with the addition of the second unit, attained a capacity of 9,000 tons. During 1911 the capacity was brought up to approximately 10,000 tons a month, and 109,800 tons were treated in the year ended June

[1] For description see Milliken, J. T., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, pp. 72–74, 1914.

[2] For description see Argall, Philip, idem., pp. 80–86.

30, 1911, and 112,391 tons in the year ended June 30, 1912, and 130,110 tons in the year ended June 30, 1913. According to the annual report [1] for the year ended June 30, 1914: Dump ore milled was 88,192 tons, mine ore 45,683 tons, total 133,875 tons; average gold content per ton 0.1439 ounce; value per ton $2.974. Concentrate produced, first grade, 1,598 tons, averaging 4.358 ounces gold per ton; second grade, 373 tons, averaging 1.848 ounces per ton. Gold recovered, in concentrate smelted 7,655 ounces; as bullion in mill, 7,764 ounces; extraction. in concentrate, 39.716 per cent; as bullion, 40.283 per cent.

The Portland Gold Mining Co.'s new concentration cyanide mill [2] was completed at Victor in June, 1910. The annual report of the Portland Co. for the calendar year 1914, says, regarding the Victor mill:

> The Victor mill treated 210,132 tons of ore during the year. Of this tonnage 18,934 tons were taken direct from the mine and the balance of 191,198 tons came as reject from the shipping grade of ore and from dumps. The contents of these 210,132 tons were $539,130.97 (or $2.5657 per ton), from which the gross values recovered were $419,961.70, (or a recovery of 77.896 per cent).

Other operating mills in the district were the Colburn-Ajax, a 300-ton cyanide-concentration mill,[3] operated continuously; the Dante (Gaylord) 75-ton cyanide leaching plant, operated 10 months; the Free Coinage 60-ton cyanide-concentration plant, which commenced operations in May and was operated the greater part of the rest of the year; the Isabella 50-ton cyanide leaching plant, with coarse crushing of ore; the Jo Dandy (Kavanaugh) cyanide leaching mill; the Rex 100-ton cyanide leaching mill, operated in the early months of 1914; and the Wild Horse 50-ton coarse crushing cyanide leaching plant. The Blue Flag 125-ton cyanide mill was idle.

MINES REVIEW.

Poverty Gulch.—The El Paso-Gold King mine continued to produce.

Hoosier Pass.—The Hoosier mine was operated by the Grafton Gold Mining Co.

North Slope of Ironclad Hill.—Producing mines were the Jerry Johnson, W. P. H., and Damon.

Gold Hill.—Producing mines were the Anchoria-Leland, Bonanza King, Caledonia, Clara D., and Midget.

Raven and Guyot Hills.—Producing mines were the Cresson, Doctor-Jack Pot, Elkton, Grace, Maggie, Mary McKinney, Jo Dandy, and Ophir.

The twenty-second annual report of the Elkton Co. for the calendar year 1914, dated February 8, 1915, shows—

> a grand total from the entire property of 39,284 dry tons, with total gross value of $641,311.14, or $16.325 per ton; total freight and treatment, $212,147.38, or $5.40 per ton; total net returns, $429,160.76, or $10.925 per ton.
>
> Early in 1914 your board of directors, * * * decided that it was necessary to extend the Roosevelt Tunnel to further open up well-known water courses, and

[1] Ore treatment and costs at Stratton's Independence for 1911–12, 1912–13, 1913–14: Min. and Sci. Press, Jan. 2, 1915, p. 29.

[2] For description see Crowe, T. B., Colorado State Bur. Mines Thirteenth Bienn. Rept., 1913–14, p. 77 1914.

[3] For description see Bryan, R. R., idem., pp. 75–76.

* * * succeeded in securing the cooperation of other producing interests in the Cripple Creek mining district, which resulted in the commencing of operations on August 3. The distance driven in a direct line was about 275 feet, which resulted in an increased flow of about 1,000 gallons per minute. * * * The distance yet to be driven before tapping the Elkton shaft is 2,400 feet. The distance to the breccia contact is about 625 feet.

In your property the recession of water has been 99.3 feet in 1914. * * * The main shaft was sunk 99.3 feet during 1914, which depth is 1,275 feet below the collar of the shaft (8,458 feet above sea level), and 365 feet above the projected elevation of the drainage tunnel. * * * In developing this level, both north and south, the main Elkton vein is found in place and of liberal width, and the initial shipment shows substantial increase in value as compared with level above. * * *

The total net tonnage of ore marketed during 1914 (from company work on the Elkton alone) was 29,509 tons of a gross value at the mine of $542,280.40 (or $18.377 per ton) and of a gross cash return value to the company of $373,423.56 (or $12.65 per ton.) * * * 3,917.3 feet of development work on the Elkton proper was accomplished in 1914. * * *

Your management has continued the plans to explore thoroughly and develop the northerly mining claims belonging to the company (known as the Ida May group), performing 1,919.5 feet of development, and has succeeded in opening up a body of ore now 140 feet long, from which shipments are being made of fair milling grade.

On the Raven and Beacon Hill Mining Co.'s property, held by your company under lease (known as Arequa lease), has been accomplished 640 feet of exploration and development work during 1914, shipping 1,100 net tons of ore of an average value of $16.01 per ton. Work on this lease is being carried on through the Elkton seventh level, thus dispensing with the cost of operating the Raven and Beacon Hill shaft, resulting in greater efficiency and economy.

Early in the year your board decided to offer for lease the territory lying above the eleventh level. Thirty-four leases were granted, which resulted in the extraction and shipping of 8,675 net tons of ore of an average value of $9.38 per ton during 1914. Nine leases have operated at a profit to themselves, and 25 leases at a loss to themselves to January 1, 1915. These leases are given on a graded royalty, based on the gross cash returns to the company. * * * From the earnings $200,000 have been paid to the stockholders in four equal quarterly payments.

The report of the Mary McKinney Mining Co. for the calendar year shows that there were produced on company account 6,039 tons of ore with a gross value of $180,599 and by lessees 2,106 tons of ore with a gross value of $34,058. The water level at the Mary McKinney should stand at 105 feet below the tenth and bottom level (1,030 feet), or 1,135 feet from the collar of the shaft. The company plans to sink the main shaft a distance of 125 feet to the eleventh level. The vein on the tenth level was found much split up.

Beacon Hill.—Producing mines were the Banner, Raaler (C. K. and N.), El Paso, Mary Nevin, Gold Dollar, Henry Adney, Mabel M., and Prince Albert.

The report of the El Paso Consolidated Gold Mining Co. for the year ended December 31, 1914, dated March 8, 1915, shows that—

Gross ore sales [were] $307,025. * * * It was found difficult to locate the ore shoots at depth, and this was especially true owing to the great distance between our 1,000-feet level and the Roosevelt Drainage Tunnel level. Particularly, the great C. K. and N. ore shoot, as it descended into the earth, dipped more rapidly to the north than [was] expected. The segment of the shoot that we expected to find to the west in the direction of the C. K. and N. property has not as yet been located. Our other great vein, the Ajax vein, also dipped to an unanticipated degree. In brief, the geological conditions below the 1,000-foot level are not yet fully understood, although it is now believed that we are at the point of interesting discoveries. * * * All of the veins in the El Paso, so far as opened up during the year, have shown strength and persistency, and a large amount of ore has been encountered, although so far of a low grade. * * * In addition to the immense amount of other work, attention is called to the fact that the Nicholls shaft has been sunk 200 feet deeper.

During the year, the Maid of Orleans and Happy Jack claims, and an option on the Mollie Gibson, were purchased from the Henry Adney Gold Mining Co. for the sum

of $38,500. These claims lay immediately to the west of our property near its north end. All of our veins were dipping to the west, and about the seventh level the Ajax vein had crossed our line on its dip. The company made energetic efforts to prove and did prove its right to the ore after departing from our side line, and thereby we made a compromise settlement with the Henry Adney people whereby our company purchased these claims at the price aforesaid, to be paid by an equal division of the net profits of the ore mined from the purchased property, after allowing our company a reasonable amount per ton for mining cost. * * *

The main surface workings of the company were destroyed by fire on November 4. The new plant is now practically completed. The buildings are fireproof and all machinery [is] operated electrically. The new equipment is such that we expect to save nearly one-half of the former cost of operation. The company now has two thoroughly up-to-date fireproof and remarkably efficient plants, one at the main shaft and the other at the Nicholls shaft. * * *

Estimate of total tonnage of rock broken in the stopes (exclusive of that broken in drifts, raises, and winzes) during the year, 10,852 tons. A small amount of work was done in the "Lonaconing" ground by lessee drifting from the third level of the "C. K. and N." shaft. This work has not been surveyed.

There is at the present time a considerable tonnage of ore broken by lessees in the various levels near the main shaft. This probably amounts to nearly, if not quite, 2,000 tons and can be hoisted as soon as the new ore house is completed. The company has a stope of about 300 feet in length cut out on the eighth or 1,170-foot level with ore still in the breast of the drift. The ore extends to the 1,000-foot level, 170 feet above. In this stope there are about 1,500 tons of ore broken. On the ninth or Roosevelt Tunnel level, at the north end of drift, a stope about 100 feet in length has been cut out to a height of about 45 feet. In this stope there are at least 500 tons of ore broken. This is a part of the same ore shoot last mentioned, and is a part of the most valuable ore body of the mine. All of this ore is in the "C. K. and N." vein. The "Ajax" vein has not yet been opened on the eighth or ninth levels. The trend of the ore bodies in the stopes on the eighth and ninth levels is to the north, and it is apparently the same ore shoot encountered on the seventh level. On that level this ore shoot was some 750 feet in length. If it should prove to be of the same length on the eighth and ninth levels and the ore of an average thickness of only 2 feet, there would be approximately 38,000 tons that could be blocked out with but very little more "dead" work. * * *

Bull Hill.—Producing mines were the Block 8, School Section 16, Blue Bird, Dante, Dexter, Gold Sovereign, Last Dollar, Modoc, Ramona, Stratton estate mines, Trilby, and Wild Horse.

Mines between Altman and Goldfield.—The producing mines were the Burns, Christmas, Findley, Golden Cycle, Isabella, Mountain Beauty, Pharmacist, Victor, and Vindicator.

The annual report of the Isabella Co. shows that the total tonnage for the year 1914 was 17,746 tons (2,040 tons dump ore, 15,706 tons mine ore), with a gross value of $345,820, as compared with 18,288 tons, with a gross value of $243,252, in 1913. In 1914 there were 10,766 feet of development work.

The Vindicator Gold Mining Co., in its annual report, shows:

That at the No. 1 shaft 76,295 tons of crude ore were produced on company account, yielding 26,343 net tons of shipping ore, of a gross gold content of $712,400, or $27.04 per ton. Lessees working through No. 1 shaft produced 3,897 net tons of shipping ore, of a gross gold content of $130,884, or $33.58 per ton. Lessees working through other shafts of the property produced 9,741 net tons of shipping ore, of a gross gold content of $192,783, or $19.79 per ton.

* * * During the year the shaft has been sunk from the 1,600-foot level to 1,943 feet, with a station cut at 1,783 feet for the 1,800-foot level, and another station cut at 1,905 feet for the 1,900-foot level.

* * * Development work on the 1,800-foot level is progressing satisfactorily. The first of our known ore bodies on the south system of veins was intersected at 433 feet from the shaft and from the appearance of the vein it is fully as good as the vein on 1,600. * * *

On October 15 the new concentrating (screening and ore sorting and washing) mill was put in operation. * * * The ore going into the mill is the ore-house waste (average value $2) or that which heretofore was thrown out on the dump.

* * * The ore from the picking tables in the ore house drops on a belt conveyor and is conveyed into the mill and discharged into a large revolving trommel. The first section of the trommel screens out all rock up to 3 inches in diameter. The oversize on reaching the second section is thoroughly washed by means of a spray under about 50 pounds pressure. The washings go at once into the settling tanks and become a shipping product after drying. After washing, the ore drops on a slow-moving wide belt conveyor, where all ore of any value is picked off by hand pickers and saved. The balance drops on a belt conveyor and is carried directly to the dump.

The material that passed through the 3-inch openings in the first trommel passes through the crusher, where it is crushed to about 1½ inches. From the crusher it is conveyed to an elevator, which elevates it to two revolving screens with ½-inch openings. The screenings are a shipping product of a value of from $11 to $16 per ton. The oversize is recrushed in the rolls to three-eighths of an inch, again elevated to a second set of revolving trommels, where it is thoroughly screened and washed. The oversize is conveyed to the dump; the undersize is concentrated and sent down to the settling tank to be dried and is a shipping product of from $10 to $20. The mill has not been in operation at this time long enough to make any positive assertions, but indications are that it will prove to be a very profitable investment. * * *

The grand total of production from April 1, 1894, to December 31, 1914, was 2,040,722 net tons, of a gross value of $38,274,933; total dividends paid to January 1, 1915, were $9,817,080.

Battle Mountain.—Producing mines were the Ajax, Carbonate Queen, Coriolanus, Dead Pine, Granite, Gold Coin, Mary Cashen, Portland, Stratton's Independence, and Strong.

The twenty-first annual report (dated Feb. 15, 1915) of the Portland Gold Mining Co. says:

During the year under review, 62,997 tons of ore were shipped to your company's plant at Colorado Springs, from which a recovery of $1,467,004.79 was made. Of this amount, 9,955 tons of a value of $224,952.12 were shipped by lessees working in your mine. In addition, 138,626 tons were delivered to the Victor mill of your company.

The gross value of the ore shipped to Colorado Springs was of lower grade than [in] the preceding year, averaging $23.421 per ton, a decrease of $2.036 per ton. There have been no changes in the mining methods, except that the mine has been worked on two shifts during 1914, whereas in 1913 most of the work was done on day shift only. The practice of keeping the stopes filled and working on broken ore has been followed wherever practicable.

Leasing operations have been confined to the 200-foot level of the No. 1 shaft, and small blocks on the outside boundaries of your property. This territory has yielded a considerable profit, but now shows signs of exhaustion.

The development work for the year gives a total of 15,592½ feet. * * * Of this amount 2,843 feet was done by lessees on the 200-foot level.

Active work was started on the 1,700-foot level on April 1 and has continued without interruption. The main No. 1 vein has been exposed a distance of 1,350 feet, of which 1,050 feet was in ore of shipping grade, the remaining distance being of a grade suitable for mining for the Victor mill. The Hidden Treasure system is now being developed on this level. * * * Crosscuts are being driven to the east and west to develop known vein systems, but are not far enough advanced to expect results. It will require a year to complete the work planned on this level, and to prospect your property thoroughly at this depth. * * *

Aside from the work on the lower levels and the leasing operations on the 200-foot level, already mentioned, the known mineral zones on the upper levels have yielded a substantial tonnage. All the pillars of ore left in the old stopes have been removed and the excavations filled with waste rock, making the old workings perfectly safe from caves. This year's work has shown that the upper levels are far from being worked out. * * * As the mine gets deeper, however, the cost of mining will naturally increase, due to the hardness of the rock and the added expense of hoisting from a greater depth. As the ventilation is poorer on the deeper levels, the work becomes more expensive. To offset this in part are the improvements in machines, mechanical haulage, and small economies that develop with time. * * *

Owing to the new extension of the Roosevelt Drainage Tunnel, the recession of water has been about 30 per cent more than last year, thus permitting mining operations under normal conditions on the seventeenth level of your mine. On the 5th of last March ore was opened on this level and the development work since performed has disclosed 1,225 linear feet of ore in the different ore shoots opened up, from which a good tonnage of ore of a shipping grade is being extracted.

Of the development work planned for the seventeenth level 4,708 feet have already been accomplished, leaving 6,500 feet yet to be driven during the coming year. In addition, 4,000 feet of development work have been planned for the upper levels of the mine, all of which is of a prospecting nature.

If the present rate of drainage continues it will allow us to sink our shaft to the eighteenth level the latter part of the present year. * * *

The report [1] for the Stratton's Independence mine for the fiscal year ended June 30, 1914, states:

Development totals 2,311 feet on company and lessee account. There were 66 men employed by the company, of whom 33 were mining on the surface and 44 lessees' men. Development was mainly directed to proving the mill veins at greater depth and following them south into the granite area. This resulted in opening new ore, as over 93 per cent of the shipping ore on company account came from these veins. They are the sole source of shipping ore mined by the company, and have yielded $237,992 to date. The estimated output for the current year is 60,000 tons. The grade is low, having averaged $2.84 per ton during the year under review. Work on the southern spurs of the Bobtail vein on No. 2 and No. 4 levels was not satisfactory. Lessess' operations in the Independence claim did not yield anything important. The Washington claim is still worked under lease. The vein at 1,150 feet is worthless. The claim produced $25,258 net, yielding a royalty of $7,935. As the mill veins may pass into this area, the output may increase this year. The output of the company and lessees in the whole property showed a decrease of $20,277 and $53,832, respectively, compared with last year. The dumps are now scattered and are costly to remove, but there should be enough for the mill for two years.

Lessees shipped 7,783 tons of sorted ore, valued at $158,173, against 10,314 tons and $229,528 in the previous year. Freight and treatment cost $48,744, while the royalty, etc., to the company was $34,992, or 31.97 per cent, leaving $74,437 net. The mill treated 369 tons of lessees' ore, giving $1,068 net and $321 royalty. Company sorted ore shipped amounted to 3,899 tons, worth $68,741, against 5,296 tons and $96,726 last year. After paying freight and treatment, there was a net return of $46,807. Company ore to the mill was 46,527 tons averaging $2.84 per ton, yielding a profit of $26,251, compared with 26,776 tons, $3.36, and $15,782 in the previous term.

* * * A dividend of 5 per cent was paid on December 10, amounting to $29,800.

LEASING IN THE CRIPPLE CREEK DISTRICT.

So many requests have come to this office for copies of forms of lease and so many persons have the idea that leasing is a development in Colorado coincident with the exhaustion of the high-grade ore bodies of the earlier periods of Colorado mining, that it seems well to quote Mr. F. L. Smale, mine manager of the Portland Gold Mining Co., on the subject of the "split-check leasing system" in Cripple Creek. Mr. Smale suggests that perhaps [leasing] was first applied in the mines of Cornwall, where contract work or mining on a tribute basis is generally practiced to this day. In Gilpin County, to which district in the early days came many men from Cornwall, we find in 1875, that "of the Gunnell mine, 800 feet have been under lease during the year to Kimber & Fullerton, and several other parties have been working on other parts of the vein." [2]

Mr. Smale says,[3] in part:

In general the system is understood to allow the lessee or tributor all the fruits of his toil, except for the payment of a certain royalty or tribute to the owner of the property on which he operates.

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[1] Min. and Sci. Press, Jan. 2, 1915, p. 51. See also Eng. and Min. Jour., Feb. 20, 1915, p. 371; also Min. Mag. (London), December, 1914, p. 394.

[2] Raymond, R. W., Statistics of mines and mining in the States and Territories west of the Rocky Mountains for 1875, p. 290, 1877.

[3] Smale, F. L., Split-check leasing system proven very effective in Cripple Creek: Min. Sci., May, 1915, pp. 41–43.

This system has been generally adopted in the Cripple Creek district, especially on the smaller properties, although all of the larger mines have at some time leased portions of their holdings. There is much to be said of the leasing plan, and also much on the other side. At this period, when the greatest hope of the future production on a large scale seems to lie in deep mining, development at great depths is of course beyond the means of the average lessee, and can be carried on only by large combinations of capital. On the other hand, to a greater extent than ever, the production from the upper levels will depend upon the activities of the lessee, as the chance of gleaning ore from worked-out territories is so uncertain that often a company is not justified in reworking that part of the mine.

The lessee, by closer supervision, harder work, and saving all his ore and handling as little waste as possible, can take this ground and usually make a profit for himself and the company. Leasing, to be profitable to the company, must also be profitable to the lessee. The cost of excavating a cubic yard of rock is a fixed charge, no matter on which system it is done; and if in addition the lessee is charged a high rate of royalty, together with a profit on supplies, hoisting, and other services furnished him by the company, he will find it impossible to operate unless he has pay ore in sight.

The management of the Portland mine has recognized this condition, and since March 1, 1913, has opened the upper levels, from the 200-foot up, to the tributary system. This plan, while not entirely new, is unique. It is called the "split-check" system, for the reason that the company furnishes all supplies, the lessee all the labor, and the check from the mill or sampler is split; or in other words, the net mill returns are divided equally between the company and the lessee. This has encouraged the lessee to his best efforts, inasmuch as the company assumed part of the risk.

The benefits to both parties were apparent at once. It opened the way for the experienced miner to exercise his skill, with no further expenditure of capital than his own time; and as the ground leased had been worked over many times, it tended to discourage many of the larger operators. This was really a benefit to the company in giving it a set of lessees who were personally interested in the ground they were working, and in general, were miners of great experience but small means, who gave all their time and attention to their particular block of ground with results which were generally satisfactory to the lessees and uniformly so to the company.

Since the 200-foot level was first opened to the lessees, there have been * * * an average of 40 men at work on this level. In the two years and one month which have elapsed, these men have shipped 15,351 tons of ore, the net mill returns from which amounted to $291,412.44. The company's share of this was $146,075.78, or $91,744.15 after all expenses, such as powder, and other supplies, hoisting, and cost of operating machine drills, and even a proportion of the overhead expenses and supervision were taken out—in fact, after deducting all charges which could be assessed against the lessees' production. This is equivalent to a net royalty of 31½ per cent, which is higher than the company could have received under any other plan of leasing. For the same period of time the lessees received $145,336.66.

The greatest benefit, however, which the company received was the development work done by the lessees. For the period stated, the lessees on the 200-foot level drove 3,224 feet of drifts, 1,484 feet of crosscuts, and 789 feet of raises, a total of 5,497 feet of development work, or a little over a mile. This work was all done in ground that had been abandoned by the company, and in which the showing would not have justified the company in undertaking that amount of development work on its own account, as the cost would not have been less than $6 per foot. It was all done within an area of 18½ acres. As it appears from the foregoing figures, the development succeeded in disclosing 2.8 tons of shipping ore for each foot of development work done. Guided by this work, the company has also opened up several new stopes on the level below, the value of which it is impossible to estimate at this time.

As conditions vary so greatly, it would be difficult to say as to whether ground can better be worked by company account or by lessees; but under the conditions mentioned above, the results of the leasing system have been eminently satisfactory both to the lessee and to the company, and go to prove that, given a fair show, the lessee will, as a rule, give value received.

The tendency in many camps has been for the owner to assume few of the risks and to take the lion's share of the profits, whereas the lessee should have a royalty commensurate with the chance he takes. His living expenses are going on the same when the streak pinches as when he has a "junction." He is expected to be enthusiastic over a piece of ground allotted him, on which the owner can not break even; and if he is fortunate enough to make wages, the public hears he is a near-millionaire.

QUICKSILVER.

By H. D. McCaskey.

INTRODUCTION.

Final figures for the domestic output of quicksilver could be issued by the Survey in the spring if all producers and operators were equally prompt in furnishing the information requested in January of each year. The majority are prompt, and only a small minority delay the report from two to three months.

Preliminary figures on the domestic output of quicksilver in 1914 were given out by the United States Geological Survey for publication on January 9, 1915. These data, compiled from earliest information obtainable for the actual production for the first 11 months and from estimates for December, gave an output of 16,568 flasks, valued (at the reported average San Francisco domestic price of approximately $49 per flask) at $811,832. Of this production California was credited with 11,469 flasks and Arizona, Nevada, and Texas combined with 5,099 flasks.

Complete and revised figures for 1914 of the United States Geological Survey give a domestic production of 16,548 flasks, valued at $811,680, of which 11,303 flasks were produced in California and 5,245 flasks came from Arizona, Nevada, and Texas combined. The total error in the preliminary figures was therefore but a little over one-tenth of 1 per cent. The error in distribution was, however, less close, the preliminary figures for California proving 1.5 per cent too high and those for the other States combined being 2.8 per cent too low. Whatever credit may be assigned for the close agreement must be given to the producers who courteously gave their early figures and estimates to the Survey.

The present report is a brief statement of the domestic industry in 1914.[1] It had been the author's hope to present a fairly full treatment of the subject at this time, but incomplete data on certain lines of investigation and new duties have postponed the attempt for another year.

CONDITION OF THE INDUSTRY.

The prevailing prices of quicksilver from January to July, 1914, inclusive, were so low that there was little profit in the industry, and undoubtedly many properties were worked at a loss and others were worked at reduced capacity, if not actually closed down; but upon the outbreak of the European war the prices rose so high that producers in a position to profit were encouraged to make their maximum output. The total productive capacity of the country, as at present known, is by no means unlimited, and although high prices may bring increased activity and new ore bodies may at any time be

[1] The statistical tables of this and preceding quicksilver reports have been compiled by Mrs. H. L. Bennit.

discovered, the outlook is not for excessive domestic production. These facts, the present difficulties in receiving supplies from Europe, and the improbability of large imports from any surplus stocks in Mexico indicate high prices throughout the war at least.

The quicksilver situation at the outbreak of the war became so interesting that some notes were prepared by the writer and were published in the form of a press bulletin by the Survey on September 28, 1914. Extracts follow:

The quicksilver situation is at present of unusual interest because of the large use of mercury in the preparation of fulminate for explosives, the present and probable future consumption of which must have an important bearing on the market for the metal, withdrawal of available supplies, and future demands. * * *

During 1904 and 1905 the United States led the world in production, but from 1906 to date the leading producer has been Spain, whose great cinnabar deposits of Almaden, the output of which has been controlled by the Rothschilds and marketed chiefly in London, have proved very rich. The deposits of quicksilver ore in Idria (western Carniola, Austria), and at Monte Amiata (Tuscany, Italy), have with those of the United States (chiefly California) furnished the bulk of the remainder of the world's supply. The figures given in the Survey report for 1913 show that during that year Spain produced approximately 1,490 metric tons; Italy, 988 tons; Austria, 855 tons; the United States, 688 tons; and Mexico and all others, 150 tons.

The production of the United States was 20,213 flasks of 75 pounds each; the imports were 2,289 flasks, and the exports 1,140 flasks, giving an approximate consumption and stocks available of 21,362 flasks, which is probably not far from the present annual needs of the United States. * * * The domestic demand is mainly for making fulminate, for amalgamation of gold and silver ores, and for manufacture of electric and other appliances. It seems unlikely that domestic production will greatly increase or that considerable exportation from Europe can be depended upon for some time to come. Domestic prices for the metal have been low in recent years, averaging for domestic, at San Francisco, $39.60 in 1907; $44.17 in 1908; $45.45 in 1909; $46.51 in 1910; $46.01 in 1911; $42.05 in 1912; and $40.23 in 1913. For 1914 the San Francisco prices ran $39.25 in January; $39 in February and March; $38.90 in April; $39 in May; $38.60 in June; and $37.50 in July. In August, following the breaking out of the European war, the price ranged between $75 and $90 a flask, although sales were reported at over $100. In September it was reported that the metal could be had in New York at $55, and possibly supplies immediately available will permit the sale for a time at $50 or thereabouts. Estimates based upon unknown stocks and future supplies are dangerous at any time, and the stocks available of this metal are at present unknown.

It would seem that the Austrian production of quicksilver, controlled as it is by the Government, is definitely cut off from the world's markets, and that the Italian supplies must be considered uncertain. The Spanish output is mainly controlled in London, and if this domination remains but little metal will be free, for a time at least, for the foreign trade. Undoubtedly large quantities of available European quicksilver will be immediately utilized in the manufacture of explosive caps for fixed ammunition for both small arms and artillery, the scale of military operations being enormous. Probably but little American metal can be imported by countries now involved in the war. Their present stocks are unknown, but even if extensive they must be heavily drawn upon for some time to come, and exportation is not only prohibited by some of these countries, but quicksilver is probably now declared contraband by all of them.

It would appear, therefore, that American quicksilver producers have an excellent opportunity to capture the trade with Central America and South America and with the Orient from Japan to India. This trade would probably not be large at first but would be worth consideration. Formerly considerable supplies of domestic metal went to Hongkong from San Francisco, but the Rothschilds are understood to have controlled this and all other markets of the Far East in recent years, as well as a considerable part of the South American trade. They have also practically dictated prices in this country. It has never been made public what stocks are available, and it may be for a short time that stocks afloat and undelivered may tend to keep down prices for the metal. Stocks held in this country, or en route or possibly available, are also unknown, but domestic supplies are certainly not excessive.

Should a considerable foreign trade in quicksilver be now built up the prices would probably be maintained for some time at higher levels than for many years past, and the opportunity is offered for American producers fully to operate and develop their properties and improve their equipment. Already prospecting for new quicksilver ore deposits has been reported active in the West. * * *

Much of the California production has been coming from old mines whose richest ore has been removed and at which it has been found difficult to operate at a profit during the prevailing low prices of the last few years—in competition with European supplies. In most of these mines special skill is required to prevent the operations from being at a loss; and in some of them possibly but little ore remains for profitable extraction. Although each well-developed property is equipped with its own plant and presumably run at lowest cost, the margin of profit has been small, in normal times, upon the low-grade ores worked. Possibly further metallurgical improvements may result in better profits, and the present time of high prices would seem the most encouraging to put mines and plants in the highest state of efficiency to meet the less profitable conditions which may follow the end of the war.

In the matter of new properties it should be noted that the present market and prices are abnormal and should not be depended on indefinitely. At the same time the domestic production has of late materially decreased and new mines of promise, efficiently and economically worked, may reasonably be expected to find some advantage in the markets even under normal conditions.

USES OF QUICKSILVER.

Quicksilver is used mainly in the manufacture of fulminate for explosive caps, of drugs, of electric appliances, and of scientific apparatus, and, to a diminishing degree, in the recovery of precious metals, especially of gold. Mercuric oxide (red oxide of mercury) is the active poison in antifouling paint used on ships' bottoms. The metal appears to be but little employed now in silvering mirrors, for which purpose nitrate of silver is the chief material used. Increasing needs of quicksilver in normal times are probably to be expected in the manufacture of blasting caps and of electric appliances, and possibly of paints for protective coatings, and industrial chemistry and inventive genius are to be looked to for finding other needs in due time. The demand for quicksilver for amalgamation of gold and silver has greatly decreased, not only with the increased application of the cyanidation process and the decrease of free-milling gold ores and of placer gravels, but also with increased efficiency and economy in stamp-milling, whereby losses of quicksilver have been reduced. The table compiled by the Survey shows the consumption of quicksilver for amalgamation in stamp mills in the Western States in 1911, 1912, and 1913.

Consumption of quicksilver in gold mining, in pounds.

State.	1911	1912	1913
Alaska [a]	15,000	15,000	15,000
Arizona	[b] 1,362	[a] 1,400	[a] 1,500
California [a]	45,000	45,000	45,000
Colorado [c]	13,221	10,622	10,834
Idaho [d]	1,648	700	254
Montana	[b] 898	[a] 750	[a] 200
Nevada	[b] 4,753	[a] 1,500	[a] 1,600
New Mexico [c]	220	187	133
Oregon [a]	250	260	350
South Dakota [c]	13,800	14,095	12,150
Utah	[b] 105	[a] 40	[a] 30
Washington [d]	526	121	130
Total	96,783	89,675	87,181

[a] Estimate based on bullion recovered by stamp-milling.
[b] Heikes, V. C., U. S. Geol. Survey Mineral Resources.
[c] Henderson, C. W., idem.
[d] Gerry, C. N., idem.

These figures indicate a consumption of only 1,150 to 1,290 flasks of quicksilver in the domestic gold industry, or about 8 per cent of the total output.

In normal times probably one-third of the domestic output is required for making blasting caps. How much more was annually used before the European war in the manufacture of percussion caps for cartridges is not known. One large ammunition factory, at least, had discontinued using fulminate of mercury for rifle cartridges. The greater part of the fulminate used in recent years in this country for loading shells and cartridges is reported to be manufactured in Canada, largely from metal supplied from mines in the United States. At present there is understood to be a very largely increased demand for the manufacture of this fulminate, the most powerful of all detonators. One flask of 75 pounds of mercury will make from 100 to 120 pounds of fulminate.

PRODUCTION.

NUMBER OF MINES, METAL OUTPUT, AND VALUE.

Including small prospects there were 30 producers of quicksilver in the United States in 1914, against 24 in 1913, and 20 in 1912. There are usually a few mines or prospects (under development only), that produce ore but no metal, and a few that produce metal only from old dumps or furnace material of earlier years. Twenty of the producers in 1914 were in California, 7 in Nevada, and 3 in Arizona and Texas combined. As in other recent years there was no output reported from Oregon, Utah, or Washington. Arizona has only produced in a very small way.

According to confidential returns to the Survey from every producing district the production of quicksilver in the United States in 1914 was 16,548 flasks of 75 pounds each, against 20,213 flasks in 1913, and 25,064 flasks in 1912. The output has therefore notably decreased in recent years and that of 1914 was the smallest since 1860. Notwithstanding the present high prices the production of metal will probably not show any immediate increase, as the total producing capacity of known and developed mines has undoubtedly fallen off.

At the average domestic price of quicksilver per flask in San Francisco, of $49.05 for 1914, based on quotations in the Mining and Scientific Press, the output was valued at $811,680. In 1913 the value was $813,171, and in 1912 it was $1,053,941. Compared with 1913 the yield of 1914 showed a falling off in quantity of 3,665 flasks, but in value (owing to the better average price for 1914) of only $1,491.

The production of California decreased from 15,591 flasks, valued at $627,228 in 1913, to 11,303 flasks, valued at $554,414 in 1914. The output of Nevada, however, increased from 1,645 flasks, valued at $66,178, to 2,089 flasks, valued at $102,465, and that of Arizona and Texas combined from 2,977 flasks, valued at $119,765, to 3,156 flasks, valued at $154,801.

The following table shows the production for 1912, 1913, and 1914:

Production of quicksilver in the United States, 1912, 1913, and 1914, by States, in flasks of 75 pounds.

State.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona	.....	.....	(a)	(a)	(a)	(a)
California	20,524	$863,034	15,591	$627,228	11,303	$554,414
Nevada	(a)	(a)	1,645	66,178	2,089	102,465
Texas	(a)	(a)	(a)	(a)	(a)	(a)
States not shown separately b	4,540	190,907	2,977	119,765	3,156	154,801
Total	25,064	1,053,941	20,213	813,171	16,548	811,680

a Included in States not shown separately.
b Nevada and Texas combined in 1912; Arizona and Texas in 1913 and 1914.

In addition to the production from ore and furnace material (soot and cleanings) given above, there is an annual output of secondary metal from the clean-up of old gold and silver amalgamation mills and from other sources. This probably tends to reduce the market for new metal only to a small degree.

PRODUCTION, 1902 TO 1914.

The production of quicksilver in the United States for the period 1902 to 1914 is shown in the following table:

Production of quicksilver in the United States from 1902 to 1914, inclusive, in flasks.[a]

Year.	Arizona.	California.	Nevada.	Oregon.	Texas.	Utah.	States not shown separately.	Total.
1902	.....	28,972	.....	.....	5,319	.....	.....	34,291
1903	.....	30,526	65	.....	5,029	14	.....	35,634
1904	.....	29,217	17	.....	5,336	745	.....	35,315
1905	.....	24,635	.....	43	4,723	1,133	.....	30,534
1906	.....	20,310	.....	3	4,761	1,009	.....	26,083
1907	.....	17,431	.....	.....	3,686	437	.....	21,554
1908	(b)	16,984	.....	(b)	2,382	.....	386	19,752
1909	.....	16,078	(b)	(b)	4,188	.....	809	21,075
1910	.....	17,211	70	.....	3,320	.....	.....	20,601
1911	.....	18,860	(b)	.....	(b)	.....	2,396	21,256
1912	.....	20,524	(b)	.....	(b)	.....	4,540	25,064
1913	(b)	15,591	1,645	.....	(b)	.....	2,977	20,213
1914	(b)	11,303	2,089	.....	(b)	.....	3,156	16,548
Total	.....	267,642	c 3,886	c 46	c 38,744	3,338	14,264	327,920

a 76½ pounds net for 1902, 1903, and 5 months of 1904; 75 pounds since June 1, 1904.
b Included in States not shown separately.
c Total for years given.

Until Texas began producing in 1899, California supplied almost the entire output of the United States from the earliest production in 1850.

ORE TREATED AND RECOVERY OF METAL.

According to reports from the producers there were 124,382 short tons of new ore mined and available for treatment in 1914, against 154,033 tons in 1913 and 166,564 tons in 1912. Of new and old ore and old furnace material there were treated 122,998 short tons in

1914, against 136,278 tons in 1913. The average recovery was 10.1 pounds of metal per ton treated, or 0.505 per cent of the ore, against 11.1 pounds, or 0.555 per cent, in 1913, and 12.1 pounds, or 0.605 per cent in 1912, and 11.5 pounds, or 0.575 per cent, in 1911.

In California 101,553 short tons were treated in 1914 with an average of 8.3 pounds of metal recovered per ton of ore treated, or 0.41 per cent of the ore, against 9.8 pounds, or 0.49 per cent, in 1913. In Nevada, 14,111 tons were treated in 1914 with an average recovery of 11.1 pounds, or 0.56 per cent, against 8,755 tons with a recovery of 14.1 pounds, or 0.71 per cent, in 1913. In Arizona and Texas combined, 7,334 tons were treated, with an average recovery of 32.3 pounds, or 1.62 per cent, against 8,364 tons, with a recovery of 26.7 pounds, or 1.34 per cent, in 1913.

The following table gives the ore treated and the recovery by States for 1914 and 1913:

Quicksilver ore treated and average recoveries, by States, in 1913 and 1914.

State.	1913			1914		
	Short tons treated.	Pounds of metal recovered per ton.	Percentage of ore recovered as metal.	Short tons treated.	Pounds of metal recovered per ton.	Percentage of ore recovered as metal.
Arizona	(a)	(a)	(a)	(a)	(a)	(a)
California	119,159	9.8	0.49	101,553	8.3	0.41
Nevada	8,755	14.1	.71	14,111	11.1	.56
Texas	(a)	(a)	(a)	(a)	(a)	(a)
States not shown separately [b]	8,364	26.7	1.34	7,334	32.3	1.62
Total and average for United States	136,278	11.1	.555	122,998	10.1	.505

[a] Included with States not shown separately. [b] Arizona and Texas combined for 1913 and 1914.

The following table shows the ore treated in retorts and in shaft furnaces and the recovery of metal from each type:

Quicksilver ore treated in retorts and in furnaces in 1914, by States.

State.	Ore treated, short tons.		Quicksilver recovered, flasks.		Percentage of metal recovered per ton of ore treated.	
	Retorts.	Furnaces.	Retorts.	Furnaces.	Retorts.	Furnaces.
California	4,411	97,142	367	10,936	0.31	0.42
Nevada	1,110	13,001	544	1,545	1.84	.45
Other States [a]	4	7,330	6	3,150	5.63	1.61
Total	5,525	117,473	917	15,631	.62	.50

[a] Arizona and Texas.

In previous reports have been given brief notes on the metallurgy of quicksilver and references to the literature on the subject. A few copies of those reports remain for free distribution.

DEPOSITS, ORES, AND GANGUES.

For detailed descriptions of domestic quicksilver deposits the reader should consult the considerable literature, including former quicksilver chapters in Mineral Resources, references to which are given in preceding Survey reports on this subject. In the report for 1911 the writer gave a summary of deposits, ores, and gangues, mainly for the benefit of those not needing numerous details, or of miners, prospectors, or others to whom the literature is not generally accessible. Prospectors have apparently found the information useful. A few copies of that report are still available for free distribution by the Survey. A more complete treatment will be published in a future report.

RESOURCES, OCCURRENCES, AND DEVELOPMENTS, BY STATES.

ALASKA.

The presence of native quicksilver and cinnabar has been known in Alaska for many years and references to it have been made in these and other Survey reports. Two prospects were visited by Philip S. Smith and A. G. Maddren, of the Alaskan division of the Survey, in 1914, and a brief report by them is now in press. The following notes by these geologists were given out as a press bulletin in advance of the report:

QUICKSILVER DEPOSITS OF THE KUSKOKWIM REGION.

The central part of the Kuskokwim basin is the only portion of Alaska where, up to the present time, lode deposits of quicksilver that have attracted serious attention have been discovered. That there were deposits of quicksilver in this region has been known since 1880, but not until the summer of 1914 were they visited by members of the Geological Survey. At two localities on the Kuskokwim—the Parks prospect and a prospect near Kolmakof—some quicksilver has been produced and sold to the gold miners of the adjacent region. The Parks prospect was visited by Philip S. Smith and the prospect near Kolmakof by A. G. Maddren.

Both of these prospects are situated close to Kuskokwim River, a large stream navigable in summer by good-sized river steamers for several hundred miles above the easternmost of the known quicksilver prospects. Ocean-going vessels can ascend the Kuskokwim to a point within 150 miles of the westernmost prospect. The river is open for navigation from June to September, inclusive, but during most of the winter even Bering Sea, beyond the mouth of the river, is blocked with ice. Small timber suitable for mine use is fairly plentiful in the better drained lowland areas, but on the hillsides it seldom extends to elevations of more than 500 feet above the Kuskokwim. Only a few settlements have been made in the Kuskokwim basin, and probably less than 100 white people live in that part which lies west of the easternmost place where quicksilver has been found. Few except the most ordinary supplies can be bought in the region, so that equipment for extensive mining or prospecting must be brought from the States. Only two small power schooners or boats on special charter visit the region once or twice a year, and no regular line of passenger steamers calls at the Kuskokwim.

Parks prospect.—The Parks prospect is about 250 miles by river upstream from the mouth of the Kuskokwim. The main workings are not more than 100 feet from the river nor more than 15 feet above it. The ore is exposed along the north bank of the river for a distance of a few hundred feet and has been found in prospect pits sunk on the hillside. The main underground development at this place has been the driving of a crosscut adit 200 feet long. Only a small amount of prospecting has been done, and even that has not been planned so as to disclose most effectively

the character and extent of the deposit. Unquestionably considerable quicksilver ore has been found, but the underground developments have not been carried far enough to block out a body of ore.

The country rock at the prospect consists of shales and sandstones which are probably of Cretaceous age. These are cut by dikes of granitic intrusive rock. The metallic minerals are almost exclusively cinnabar and stibnite. Near the surface the ore is weathered to a rusty brown, iron-stained color. In the more oxidized parts of the deposit the cinnabar is practically unrecognizable by inspection, owing to the coating of iron oxides. In the less decomposed parts the characteristic red of the cinnabar becomes more evident, until in the unaltered parts the blood-red cinnabar is very striking. A little metacinnabarite, the black sulphide of quicksilver, was recognized. No livingstonite nor any compounds of quicksilver and selenium or tellurium were found.

The relations of the mineralized body were best exposed in the crosscut adit. The first 75 feet of the adit was driven through unmineralized sedimentary rocks. A 3-foot dike follows. The country rock adjacent to the dike and the dike itself are somewhat mineralized. Beyond the dike the sediments are followed by 100 feet of igneous rock which is sparingly mineralized. At the northern limit of the wide igneous dike more black shale containing considerable cinnabar was disclosed.

The amount of exploration has not been sufficient to determine the size or shape of the igneous masses, but judged from surface indications they are not large and they appear to be more or less cylindrical bodies rather than extensive plugs or batholiths. The mineralization seems to be most abundant in the brecciated zones adjacent to the igneous intrusives. Where several dikes whose margins are mineralized occur exaggerated estimates of the possible future tonnage are likely to be made unless the true geologic structure and relations are determined.

As is well known, the members of the Geological Survey do not commercially sample ore bodies, so that no statement can be made as to the tenor of the deposit. Until this important factor has been ascertained and until the deposit has been carefully prospected, the value of the property can not be determined.

Prospect near Kolmakof.—The prospect near Kolmakof has been known for more than 25 years. It is situated on the north side of the Kuskokwim, about 4 miles below Kolmakof. No work was in progress on this prospect in 1914, and the earlier developments consist of a few shallow pits which do little more than expose the rock surface. The country rock is essentially the same as that at the Parks prospect. It is intruded nearly parallel with the bedding by igneous rocks. The quicksilver mineralization occurs mainly in the shattered country rock adjacent to one of the small dikes, but cinnabar has also been recognized apparently as an original constituent of the dike rock. The maximum width of the mineralization, including the dike, which is 1 to 2 feet wide, appears in the small part of the outcrop that is undisturbed by creep to be about 4 feet. The cinnabar is especially abundant in the quartz stringers and lenses. Few of these are more than 6 inches thick or more than 2 feet long. The thickest band of fairly pure, more or less crystalline cinnabar observed was about a quarter of an inch wide. Although the sedimentary rocks on each side of the dike are probably impregnated with cinnabar in appreciable amounts, probably no quicksilver ore of commercial grade occurs outside of the narrow area in association with the smaller sill. Although the amount of ore exposed in the existing workings does not seem sufficient to be profitably exploited under the present conditions of the region, intelligently directed prospecting might possibly disclose larger ore bodies.

Miscellaneous prospects.—Several claims have been staked on the Kuskokwim-George River divide about 2½ miles northwest of the Parks prospect. Some quicksilver ore has been found, but the development has not been carried much further than that required by law to hold the property. The geologic conditions in general are the same as at the Parks prospect and the prospect near Kolmakof; dikes cut the sandstone and shale country rock, and in the vicinity of the contacts mineralization has taken place.

Cinnabar has been found also in the placer material in the areas of intrusive rock near Iditarod. It has been found in place associated with quartz in some of the small veins that occupy joint cracks on the lower part of Glen Creek, in the Iditarod district. At none of these places, however, has a body of ore of sufficient size or richness to tempt exploitation been discovered.

Conclusions.—The mineralization by which the quicksilver was introduced seems clearly to have accompanied the intrusion of the igneous dikes which have a rather widespread distribution in the areas of Cretaceous rocks. The deposition of the quicksilver minerals took place in the shattered zone adjacent to these intrusives. None of these areas have yet been adequately prospected. The geologic indications point to the conclusion that workable deposits of quicksilver may occur in the region, but whether or not the development of a specific deposit promises adequate financial returns can be ascertained only by a critical investigation, which should include

careful sampling, detailed mapping, and thorough analysis of all the other factors that determine the valuation of mining properties. In order to find out these facts sufficient capital for adequate prospecting is needed, and its employment for this purpose is fully justified.

ARIZONA.

There was no output of quicksilver in Arizona in 1911 or 1912, but in 1913 and in 1914 a very small production was reported from both Maricopa and Yuma counties.

Gila and Maricopa counties.—In the Mazatzal Mountains, on the northeastern boundary between Maricopa and Gila counties, there has been considerable activity in prospecting for quicksilver since the close of 1912. The ore is cinnabar associated with quartz in greenish schists. The locality has taken the name of the Sunflower district from the Sunflower ranch, about 8 miles south, on Sycamore Creek, and the district extends over the Mazatzal Range into Gila County on the east, where cinnabar has also been found, and claims have been staked out. The principal locations and work, however, have been on the west side of the range, in Maricopa County, near the headwaters of Sycamore Creek, and including Pine Mountain. A number of claims were located here by Messrs. Bowman, Murphy, and others, and the Sunflower Cinnabar Mining Co., of Phoenix, took over some of these and continued work for a time. The Maricopa Quicksilver Co. controls claims about 1 mile northeast of the Sunflower properties. A nominal output has been made to date from the Sunflower claims from small quantities of ore treated in a retort. A Scott furnace was planned but is not yet erected. There has been some change in organization and the district really awaits further development. The region was visited by F. L. Ransome, of the United States Geological Survey, in the later part of 1914, and a brief report by him is about to be issued.

Yuma County.—The Cinnabar Development Co., operating claims in the Quartzite district of Yuma County, referred to in previous Survey reports, has produced a nominal quantity of quicksilver in the last two years partly from ore on the dumps mined in previous years. The property has had a 30-ton Scott furnace and a 3-ton Johnson-McKay retort plant. The mine was shut down in 1914.

CALIFORNIA.

The quicksilver industry was again quiet in California in 1914 until the outbreak of the war, when higher prices led to renewed prospecting and development. The few larger operators again produced the greater part of the output.

The production of quicksilver in California in 1914 was 11,303 flasks, valued at $554,414, a decrease from the output of 1913 of 2,288 flasks and $72,814. It was the smallest production in quantity and value in California since 1860. In 1914 California furnished 68.3 per cent of the total domestic output, against 77.1 per cent in 1913, 81.9 per cent in 1912, 88.7 per cent in 1911, 83.5 per cent in 1910, and 76 per cent in 1909.

The following table shows the output of quicksilver in California from the year of the earliest recorded production, 1850, to date, giving best available data for quantity, the average price per flask, and annual value at San Francisco. The flask was 76½ pounds net of quicksilver until June, 1904, and has since been 75 pounds net.

Quicksilver production of California, 1850–1914, in flasks.

Year.	Flasks.	Price per flask.	Value.	Year.	Flasks.	Price per flask.	Value.
1850	7,723	$99.45	$768,052	1884	31,913	$30.50	$973,347
1851	27,779	66.93	1,859,248	1885	32,073	30.75	986,245
1852	20,000	58.33	1,166,600	1886	29,981	35.50	1,064,325
1853	22,284	55.45	1,235,648	1887	33,760	42.375	1,430,580
1854	30,004	55.45	1,663,722	1888	33,250	42.50	1,370,625
1855	33,000	53.55	1,767,150	1889	26,464	45.00	1,190,880
1856	30,000	51.65	1,549,500	1890	22,926	52.50	1,203,615
1857	28,204	48.73	1,374,381	1891	22,904	45.25	1,036,406
1858	31,000	47.83	1,482,730	1892	27,993	40.71	1,139,595
1859	13,000	63.13	820,690	1893	30,164	36.75	1,108,527
1860	10,000	53.55	535,500	1894	30,416	30.70	933,771
1861	35,000	42.05	1,471,750	1895	36,067	37.04	1,335,922
1862	42,000	36.35	1,526,700	1896	30,765	34.96	1,075,544
1863	40,531	42.08	1,705,544	1897	26,691	37.28	995,040
1864	47,489	45.90	2,179,745	1898	31,092	38.23	1,188,647
1865	53,000	45.90	2,432,700	1899	29,454	47.70	1,404,956
1866	46,550	53.13	2,473,202	1900	26,317	44.94	1,182,686
1867	47,000	45.90	2,157,300	1901	26,720	48.46	1,294,851
1868	47,728	45.90	2,190,715	1902	28,972	43.20	1,251,590
1869	33,811	45.90	1,551,925	1903	30,526	45.29	1,382,523
1870	30,077	57.38	1,725,818	1904	29,217	43.50	1,270,940
1871	31,686	63.10	1,999,387	1905	24,635	36.22	892,280
1872	31,621	65.93	2,084,773	1906	20,310	39.50	802,245
1873	27,642	80.33	2,220,482	1907	17,431	39.60	690,268
1874	27,756	105.18	2,919,376	1908	16,984	44.17	750,183
1875	50,250	84.15	4,228,538	1909	16,078	45.45	730,745
1876	72,716	44.00	3,199,504	1910	17,211	46.51	800,484
1877	79,395	37.30	2,961,434	1911	18,860	46.01	867,749
1878	63,880	32.90	2,101,652	1912	20,524	42.05	863,034
1879	73,684	29.85	2,199,467	1913	15,591	40.23	627,228
1880	59,926	31.00	1,857,706	1914	11,303	49.05	554,414
1881	60,851	29.83	1,815,185				
1882	52,732	28.23	1,488,624	Total	2,151,636		96,457,337
1883	46,725	28.75	1,343,344				

The total value of the quicksilver produced in California from the earliest output to date may be taken at $96,457,337. The highest annual value in this period of 65 years was $4,228,538, in 1875, when the output was 50,250 flasks of 76½ pounds each, and the average annual price was $84.15 a flask; and the lowest value was $535,500, in 1860, when the output was estimated at 10,000 flasks, and the average price was $53.55. The highest number of flasks produced in any one year was 79,395, in 1877, and the lowest was 7,723, in 1850. The highest price was $105.18, in 1874, and the lowest was $28.23, in 1882. For the period of 65 years the average annual value was $1,483,959, the average annual output was 33,102 flasks, and the average annual price per flask was $44.83—whether the flasks were of 76½ or 75 pounds each.

The production of quicksilver in 1914 increased somewhat in Lake, San Luis Obispo, Solano, and Sonoma counties and decreased in Napa, San Benito, Santa Barbara, and Santa Clara counties. No production has been reported from Colusa, Kings, Monterey, Siskiyou, or Stanislaus counties for several years.

San Benito County, in which are the New Idria mines, the largest producers in all the Americas, led, as usual, in output of quicksilver in California. Next in rank was Santa Clara, with the greatest total production to date, in which are the famous New Almaden and the New Guadalupe mines. Third in rank was San Luis Obispo, with the Oceanic mine in active operation and the Cambria and other properties under renewed development.

There were 20 producing quicksilver mines and prospects in California in 1914. The total quantity of ore mined was 95,348 short tons, and that treated, together with old material, amounted to

101,553 tons. In 1913 the quantity of ore mined was 123,464 tons, and that treated was 119,159 tons. Of the ore treated in 1914 the retorts received 4,411 tons, producing 367 flasks of metal, and the furnaces 97,142 tons, yielding 10,936 flasks.

The production of quicksilver in California in 1912, 1913, and 1914 is shown, by counties, in the following table:

Production of quicksilver in California, by counties, during 1912, 1913, and 1914, in flasks of 75 pounds.

County.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fresno and Lake	436	$18,334	694	$27,920	479	$23,495
Napa	286	12,026	260	10,460	119	5,837
San Benito	9,754	410,156	9,718	390,956	6,621	324,761
San Luis Obispo	609	25,608	1,241	49,926	1,336	65,531
Santa Clara	8,695	365,625	3,562	143,299	2,362	115,856
Sonoma	(a)	(a)	(a)	(a)	31	1,521
Other counties b	744	31,285	116	4,667	355	17,413
Total	20,524	863,034	15,591	627,228	11,303	554,414

a Included in "Other counties."
b Includes Santa Barbara, Sonoma, and Trinity counties in 1912 and 1913; Santa Barbara, Solano, and Yolo counties in 1914.

Colusa County.—The Manzanita mine remained idle in 1914.

Fresno County.—The old Mercy mine, near South Dos Palos, in Fresno County, was operated part of the year by the Pacific Quicksilver Co., which named it the Little Panoche mine. This company first built a coarse-ore furnace, in which 4,000 or 5,000 tons of ore were treated unsuccessfully, and then a Scott 20-ton fine-ore furnace which produced in all several hundred flasks from 7,000 or 8,000 tons of ore. In June, 1914, according to reports, the ore bodies were lost but were found again by J. Norrish on contract work. Later the property reverted to the original owners, the Mercy Mining & Development Co.

Kings County.—The Summit property, near Parkfield, in Kings County, was equipped with a 10-ton Scott furnace in 1914, and a concentrator was also nearing completion, according to reports from the superintendent. On the Segregation claims assessment work was done.

Lake County.—The quicksilver produced in Lake County again came from the Helen and Wall Street mines, brief descriptions of which were given by the writer in the Survey report for 1912. In the Wall Street a new ore body was cut and prospects were reported good for more and better ore. At the Helen mine production was mainly from new ore, but some old stope filling was also reduced in the furnace. The other mines of the county, including the Mirabel and Great Western, were all idle in 1914.

Mariposa County.—The Orestimba prospect was under assessment work and a nominal quantity of ore was retorted for tests of its value.

Monterey County.—The Pitts property, near the Kings County line, was equipped with a battery of 12 pipe retorts in 1914.

Napa County.—The production of Napa County was 119 flasks, valued at $5,837, in 1914, against 260 flasks, valued at $10,460, in 1913.

The principal producers were the Oat Hill and the Aetna mine, and a nominal output was reported from the Knoxville mine. Practically all the output was produced by working over old dumps. At both the Oat Hill and the Aetna mine interesting experiments were continued in concentrating cinnabar from material taken from old dumps. At the Aetna mine development work uncovered a rather large ore body but its metal content was low. The 60-ton furnace was idle and concentrates were treated in retorts. It was reported that concentration had not yet proved successful, as the cinnabar is crushed so fine that it fails to sink on the tables. Concentration at the Oat Hill mine was more successful and attracted considerable attention. Large quantities of material that had been rejected in earlier years are reported to be available for profitable treatment by wet screening and concentration. The Knoxville mine was closed in the early part of the year.

San Benito County.—The production of quicksilver in San Benito County in 1914 was 6,621 flasks, valued at $324,761, against 9,718 flasks, valued at $390,956, in 1913, and 9,754 flasks, valued at $410,156, in 1912. The output was almost wholly from the New Idria mines, as usual, but small production was also reported from the Alpine, Hernandez, and I. X. L. mines. The Florence Mac and Esmeralda properties made no output.

Two severe storms in the Idria district in the spring of 1915 did much damage and greatly hindered mining and production.

At the Alpine properties development work was continued, with favorable prospects, according to reports, and furnace equipment was planned. At the Florence Mac assessment work only was done. The Hernandez (formerly Ramirez) made a nominal output from a 4-pipe retort. The Esmeralda was closed down pending installation of new equipment. On the Archer prospect assessment work was done, and on the Tiger prospecting continued. On the I. X. L. property development work was done, and a small output was made from ore mined in 1911 and was treated in a D retort.

The New Idria mine continued to be the most important quicksilver producer in America. The mine was briefly described by the writer in the Survey report for 1908. The property is equipped with 3 Scott furnaces, 1 for fine and 2 for coarse ores, with a capacity of 80 tons each per day. A large amount of prospecting work was done in the main (Idria) workings and the tunnel into the San Carlos workings was continued. There has been some decrease in tenor of ore, and there is little expectation of increased output at the New Idria in 1915; but the development work being carried on may lead to somewhat better output in the latter part of the year or in 1916.

San Luis Obispo County.—The production of quicksilver in San Luis Obispo County was 1,336 flasks, valued at $65,531, against 1,241 flasks, valued at $49,926, in 1913. The output was again mainly from the Oceanic mine, where a large amount of development work has been done, especially on the lower levels, in the last few years. The mine has been equipped with a 50-ton Scott furnace, 2 D retorts for treating furnace soot, and a small concentration plant for handling wet ores. The Cambria mine was reopened late in 1914, and, according to reports, prospecting and development work were promising. On the Doty property and at the Rinconada and others prospecting for pay ore continued. The Klau mine was again idle, as was the

Capitola. The Little Bonanza was operated until the death of its owner, J. W. Bagby, and made a small output. The Karl mine, worked under lease, was also a producer on a small scale, the ore being treated in pipe retorts. The Libertad mine was operated by the Belt Mining Co., which did considerable development and other work and had the erection of a 20-ton Scott furnace under advisement.

Santa Barbara County.—In Santa Barbara County a small output was made from the Los Prietos mine, which is equipped with 26 retorts of the Johnson-McKay type and upon which considerable development work has been reported for 1914. The Acachuma was also operated and was a producer for part of the year.

Santa Clara County.—The quicksilver production of Santa Clara County was 2,362 flasks, valued at $115,856, in 1914, against 3,562 flasks, valued at $143,299, in 1913.

At the old Phoenix property men were at work retimbering. At the New Guadalupe a considerable quantity of ore was again mined and treated in the Davey 20-ton furnace. At the New Almaden mine production continued from the treatment of old dumps, but no new operations were under way. This famous old mine has made the largest production to date, but the underground workings have been practically abandoned in recent years, operations consisting mainly in prospecting for new veins and in working over old material.

Siskiyou and Solano counties.—In Siskiyou County some work on a cinnabar prospect was done in 1914 by F. T. Osborn, and in Solano County development work was diligently pushed on the old St. Johns mine by Clifford G. Dennis, lessee, and the old furnaces were being repaired. Coarse ore was treated in the furnaces and the fines were reserved for future treatment.

Sonoma County.—The Culver-Baer mine in Sonoma County was not operated in 1914, but the Cloverdale, Great Eastern, and Eureka properties made a small output. The Cloverdale was equipped with a new plant late in the year. At the Great Eastern experiments were made in concentrating the ore and in retorting the concentrates. At the Eureka little but assessment work was done. According to reports, the Socrates mine has been closed on account of a fire.

Stanislaus County.—At the Newhall property in Stanislaus County development work was reported on a body of low-grade ore.

Trinity County.—Neither the Altoona nor the Integral mine in Trinity County made any production in 1914.

Yolo County.—At the Reed property, in Yolo County, there was a small output from retorts. According to reports, operations were not on a large scale.

IDAHO.

There has been no production of quicksilver or operation of quicksilver properties reported to the Survey from Idaho for the last three years. The occurrences of cinnabar in the State were described in the Survey report for 1911.

NEVADA.

The production of quicksilver from Nevada in 1914 was 2,089 flasks, valued at $102,465, against 1,645 flasks, valued at $66,178, in 1913. There were 7 producers in 1914, against 3 in 1913, and 13,001

tons of ore were treated in furnaces, yielding 1,545 flasks of metal, and 1,110 tons were treated in retorts yielding 544 flasks.

The occurrences of quicksilver ore in Nevada and references to the literature were given in considerable detail by the writer in the Survey report for 1911.

Humboldt County.—The Ruby quicksilver mine made no output in 1914, but the Goldbanks, about 35 miles south of Winnemucca, on the west side of the Sonoma Range, upon which extensive bodies of good ore have been reported, produced metal from ore treated in pipe retorts and also in a muffle D retort. There was some prospect of equipping this property with a standard shaft furnace, as the recovery by retorts was not entirely satisfactory.

The Dolbear mine, near Antelope Springs, equipped with a 12-pipe retort, was actively operated and produced a considerable quantity of ore and metal. Large bodies of low-grade ore, lying above black siliceous limestone, are reported available for extraction at a profit by quarrying methods.

Mineral County.—In the Pilot Mountains, about 13 miles east of Mina, Mineral County, there has been considerable prospecting, and a number of claims have been staked out, following the discovery of cinnabar by Tom Pepper and Charles Keogh in 1913. No reduction plants had been erected to the close of 1914, and only a few pounds of metal were obtained in making preliminary tests of the ore. There was some prospect for at least one furnace to treat the ore. The district was visited by Adolph Knopf, of the Survey, in 1914, and a brief report embodying the results of his investigations is in press.

Nye County.—The quicksilver deposits of the old Ione district, on the west side of the Shoshone Mountains, in Nye County, were briefly described by the writer in the Survey report on quicksilver for 1911.

The production of quicksilver in Nye County in 1914 was 1,550 flasks, valued at $76,027, from 13,002 tons of ore mined and treated in shaft furnaces, principally at the Nevada Cinnabar and the Mercury mines of the Ione district. A small output was also reported from the Telluride group, on Bare Mountain, in the Fluorine district.

The 25-ton Scott furnace at the Mercury mine was not operated from February to October, 1914, and the output therefore decreased; but the plant was reported on a producing basis again during the last three months of the year. The new 50-ton Scott fine-ore furnace of the Nevada Cinnabar mines was completed in May and the first shipments of metal were made in August, after which a notable output was made.

At the Fahy prospect, southwest of Austin, development work is reported to have shown considerable bodies of ore.

At the Telluride properties, in the Fluorine district, a small output was made by lessees from the operation of a 10-ton Scott furnace, and later some experiments were conducted by J. B. Kiernan in concentrating ores on Wilfley tables and treating the concentrates in a D retort, which resulted in a small additional yield. It has been reported that these experiments were not successful and that operations have been suspended. The quicksilver deposits were visited by Adolph Knopf, of the Survey, in 1914, and a brief report resulting from his investigations is now in press.

OREGON.

There have been no operations of quicksilver properties reported from Oregon in the last three years. The occurrences of cinnabar and references to the literature were given in some detail in the Survey report for 1911.

TEXAS.

Figures for the quicksilver output of Texas for the last four years have been combined with those of other States to conceal individual production.

The following table shows the production of quicksilver in Texas from the beginning of operations in 1899 to the end of 1910:

Production of quicksilver in Texas, 1899–1910, in flasks.[1]

1899	1,000	1904	5,336	1909	4,188
1900	1,800	1905	4,723	1910	3,320
1901	2,932	1906	4,761		
1902	5,319	1907	3,686	Total	44,476
1903	5,029	1908	2,382		

Brewster County.—The quicksilver deposits of the Terlingua region, of Brewster County, which have supplied the entire output from Texas, have been briefly described by the writer in the Survey reports for 1907 and for 1910, and lists of references to the literature have been given.

The only operations in the Terlingua region since 1910 have been at the Chisos mine, which has been continuously under active development and has made notable annual output since it was first opened up. It has been frequently referred to in previous reports of this series.

UTAH.

There has been no production of quicksilver in Utah since the closing of the Sacramento gold mines, at Mercur, where a considerable output had been made as a by-product. In 1914, however, H. L. Stratton, a prospector, located the Marietta claim, in Willard County, upon which he reported a 4-foot vein in which a promising cinnabar content was shown at a depth of 6 feet.

WASHINGTON.

At the Leavenworth prospect, in Chelan County, Wash., there were no new developments in 1914, but some inquiries have been made since relative to the erection of a small reduction plant at the property.

WORLD'S PRODUCTION.

The following table gives the estimated world's production of quicksilver, in flasks of 75 pounds each, for the 10-year period, 1905–1914. For foreign countries the figures are mainly from the twentieth annual issue of "Comparative statistics," compiled by the Metallgesellschaft, Metallurgischen Gesellschaft A. G., and the Berg- und Metallbank Aktiengesellschaft, of Frankfort on the Main, Germany.

[1] Flasks, 76½ pounds net before June 1, 1904; 75 pounds since June 1, 1904.

The original figures are in metric tons, but they have been converted into flasks of 75 pounds each for use in this table. The figures have been kindly furnished the Survey through the courtesy of the American Metal Co. For 1913 and 1914, as noted in the footnotes, the writer is indebted to Prof. G. L. Roush, of the Mineral Industry, for certain data. Figures for the United States are in all cases those of the United States Geological Survey.

World's production of quicksilver, 1905–1914, in flasks of 75 pounds each.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
United States	30,534	26,083	21,554	19,752	21,075	20,601	21,256	25,064	20,213	16,548
Austria-Hungary	16,755	16,961	16,667	18,519	17,902	20,400	23,310	23,016	[a]26,720	[b]
Italy	10,847	12,287	12,434	19,989	22,664	26,279	27,367	28,983	[a]29,513	[a][c]22,340
Russia	9,348	6,173	3,821	1,440	206	118	.....	.....	.....	[b]
Spain	25,074	46,062	35,627	31,394	40,947	32,746	[c]43,681	[c]43,799	[c]43,799	[b]
Mexico and other countries	[d]5,585	[d]5,879	[d]5,879	[d]5,879	[d]4,409	[d]4,409	[d]4,409	[d]4,409	[d]4,409	[b]
Total	98,143	113,445	95,982	96,973	107,203	104,553	120,023	125,271	124,654	.....

[a] The Mineral Industry.
[b] Statistics not available.
[c] Export figures only.
[d] Estimated.

An examination of this table discloses an interesting and important general increase of world output of quicksilver in the period covered which has had a very manifest bearing on prices in this country, as metal has heretofore been readily imported to take advantage of any temporary demand here resulting in improved prices. The world has probably produced, in recent years, more quicksilver than was required, and some stocks had undoubtedly accumulated prior to the European war. On the outbreak of the war the Austrian supplies were cut off and the Spanish supplies, controlled in London, were not available for export to this country. Since Italy entered the war the domestic producers, who have been encouraged by increased demand and high prices, have been without serious competition from abroad. It is interesting to note that the famous Idria mines, of Austria, lie not far from the present Austro-Italian battle front.

IMPORTS AND EXPORTS.[1]

The import tariff on quicksilver from 1890 to 1895 was 10 cents per pound; from 1895 to 1913 it was 7 cents; and the Underwood tariff bill, enacted in 1913 and now in force, made the tariff 10 per cent ad valorem, which for the whole year 1913 would be roughly equivalent to 5.3 cents a pound and for 1914 to 6.4 cents, based on the average New York price. On the London price the rate would be roughly 4.8 cents for 1913 and 4.6 cents for 1914.

In the following tables are shown the imports of quicksilver for domestic consumption in pounds, the exports in flasks, and the exports by countries in pounds. Both imports and exports are shown to have increased in 1914, the former very notably. As indicated in previous portions of this report, the imports during the remainder of the European war may be expected to fall away, leaving the domestic market, with all its increasing demand and prices, to domestic producers.

[1] For statistics of imports and exports grateful acknowledgment is made to the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Quicksilver imported and entered for consumption in the United States, 1905–1914, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1905	2,690	$1,710	1910	667	$381
1906	84	50	1911	471,944	251,386
1907	16,567	6,719	1912	82,706	39,920
1908	15,113	8,216	1913	[a] 171,653	75,361
1909	15,968	8,203	1914	[b] 614,869	271,984

[a] Of this quantity 97,976 pounds came from England (presumably Spanish), 42,565 pounds came from Germany (origin not known), 22,500 pounds came from Italy, and 8,000 pounds came from Austria, or 171,041 pounds in all, received in New York in 1913.

[b] Of this quantity 60,000 pounds came into the port of Philadelphia from England in 1914; and 323,960 pounds from England, 218,441 pounds from Italy, 57,554 pounds from Austria, 28,145 pounds from Mexico, and 12,860 pounds from European Turkey entered the port of New York in 1914. Some of this may have been for reexport as the total entered for consumption is given at 614,869 pounds for the entire country.

Exports of quicksilver from the United States, 1905–1914, in flasks of 75 pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1905	13,534	$489,756	1910	1,923	$91,077
1906	6,456	243,914	1911	291	13,995
1907	5,132	192,094	1912	310	13,360
1908	2,996	124,960	1913	1,140	43,574
1909	6,802	266,243	1914	1,446	70,753

Exports of domestic quicksilver from the United States, 1912–1914, by countries, in pounds.

Country.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Europe:						
England			215	$140		
France					44,350	$31,070
Netherlands					383	230
North America:						
Canada	6,413	$3,598	80,162	40,362	23,950	15,371
Newfoundland						
Mexico	3,130	1,816	1,500	821	2,086	1,054
Central America:						
Costa Rica	4,150	2,447	306	165	360	236
Guatemala	900	505				
Honduras	409	287	75	43	1,363	897
Nicaragua	355	251	750	483		
Panama	95	64	103	74		
Salvador	300	160	675	368	225	115
Outlying Islands:						
Cuba	75	43			225	175
Dutch West Indies	25	18				
Dominican Republic	280	170	89	41	18	13
South America:						
Bolivia			92	53		
Brazil						
Chile					1,870	1,250
Colombia	1,030	562	1,090	738	1,952	1,309
Ecuador						
Venezuela	4,546	2,539	89	67	1,644	1,033
British South Africa					30,000	18,000
Asia:						
Chosen (Korea)	1,575	900				
Hongkong			150	84		
Philippines			225	135		
Total	23,283	13,360	85,521	43,574	108,426	70,753

PRICES.

Prices of quicksilver materially declined in 1912, 1913, and during the first part of 1914, and seriously affected the prosperity of the industry. As shown by the tables below, however, the prices have risen greatly since the outbreak of the European war, and domestic producers are now in a position to profit.

The prices given in the following table for New York and London are taken from the Engineering and Mining Journal. As the primary domestic market is San Francisco, the price there is averaged from the weekly and monthly market quotations published in the Mining and Scientific Press. The prices received by producers in individual sales varied, of course, from the market prices as published, which are annual averages of generally prevailing quotations.

Average yearly prices of quicksilver in the United States and London from 1907 to 1914, inclusive.[a]

[Per flask of 75 pounds.]

Year.	San Francisco (domestic).	New York.	London.
1907	$39.60	$41.50	.....
1908	44.17	44.84	.....
1909	45.45	46.30	.....
1910	46.51	47.06	.....
1911	46.01	46.54	.....
1912	42.05	42.46	$39.61
1913	[b] 40.23	39.54	35.91
1914	[b] 49.05	48.31	[c] 34.80

[a] From Eng. and Min. Jour., New York.
[b] From Min. and Sci. Press, San Francisco.
[c] January–July, inclusive.

The following table shows the average monthly quotations for 1914 and part of 1915, San Francisco (domestic), as published in the Mining and Scientific Press of August 7, 1915:

Prices at San Francisco (domestic), 1914–15.

[Per flask of 75 pounds.]

Month.	1914	1915	Month.	1914	1915
January	$39.25	$51.90	July	$37.50	$95.00
February	39.00	60.00	August [a]	80.00	.....
March	39.00	78.00	September	76.25	.....
April	38.90	77.50	October	53.00	.....
May	39.00	75.00	November	55.00	.....
June	38.60	90.00	December	53.10	.....

[a] Market fluctuated greatly at outbreak of European war.—H. D. McC.

LITERATURE.

Fairly complete lists of references to the literature on quicksilver for the North American continent have been given in previous Survey reports by the writer (especially for 1910 and 1911), and a new and complete list is in preparation for the report for 1915.

PLATINUM AND ALLIED METALS.

By James M. Hill.

PRODUCTION.

CRUDE PLATINUM.

Notwithstanding the lower price received for crude platinum in 1914 than in 1913, the production of both California and Oregon shows an increase over former years. In 1914 California produced 463 ounces of crude platinum which was about 80 per cent fine—that is, it contained 450 ounces refined platinum-group metals—and Oregon produced 107 ounces of crude platinum considered 70 per cent fine, containing 75 ounces refined platinum-group metals. The total of 570 ounces crude sands sold for $18,240, or approximately $32 an ounce.

The yield from Oregon in 1914 was 107 ounces as compared with 22.5 ounces in 1913. This increase was due in great measure to larger operations of a few companies rather than to an increase in the number of producers, and is explained by the greater recovery resulting from the installation of more improved concentrating machinery. All reports indicate that the large increase in 1914 over the production of 1913 should be at least repeated in 1915, for several companies have declared their intention of undertaking developments in the beach diggings, from which most of the Oregon platinum is obtained.

In California in 1914, as heretofore, the largest output of platinum came from the gold dredges of Butte, Sacramento, and Yuba counties; but the placers in Trinity and Siskiyou counties did not produce as much platinum in 1914 as in 1913.

The production of gold ore carrying platinum and palladium in 1914 from the Boss mine of the Yellowpine mining district, Clark County, Nev., added to the domestic production 110.5 ounces of platinum and 168.16 ounces of palladium.

REFINED PLATINUM.

A considerable output of platinum is annually made in the United States from the refining of gold and copper bullion of both domestic and foreign origin.

Reports received from the refiners of platinum sands, gold bullion, and copper matte indicate that 3,430 ounces of new refined platinum were recovered by them. Of this quantity 525 ounces came from domestic crude placer platinum, and probably at least 2,500 ounces in all were derived from domestic sources. The 930 ounces unaccounted for were obtained from foreign material which is treated in this country and not reported elsewhere.

Besides the refined platinum obtained, as estimated from new material, 40,698 ounces of refined platinum were derived from scraps, sweepings, and like material. It should be borne in mind, however, that any report on production from scraps, particularly in metal so valuable as platinum, must necessarily contain much duplication, as some of the material probably enters the market several times in the course of a year, particularly sweepings and scraps obtained from the jewelry and dental trades.

The following tables show the total quantity of new and of scrap platinum-group metals reported as handled during the year 1914 in the United States:

Production in the United States of new refined platinum and allied metals in 1914.

Platinum.		Iridium, total production.	Iridosmine (osmiridium), total production.	Palladium, total production.
From domestic crude placer.	Production.			
Troy oz. a525	*Troy oz.* 3,430	*Troy oz.* 64	*Troy oz.* 195	*Troy oz.* 2,635

a Includes some iridium and iridosmium.

Secondary platinum and allied metals sold in United States in 1914.

Platinum.	Iridium.	Iridosmine.	Palladium.
Troy oz. 40,698	*Troy oz.* 129	*Troy oz.* 18	*Troy oz.* 1,500

PRICES.

The following table gives the prices of ingot platinum per troy ounce at New York, by months, for the calendar years 1909–1914:

Prices of ingot platinum per troy ounce on the New York market,[1] 1909–1914, by months.

1909.

January	$24.25	July	$22.50
February	24.50	August	22.00
March	23.75	September	25.50
April	24.00	October	28.00
May	23.50	November	29.25
June	23.00	December	29.50

1910.

January	$29.00	July	$33.00
February	28.75	August	33.00
March	29.13	September	33.63
April	29.25	October	37.50
May	29.55	November	39.44
June	31.38	December	38.75

[1] Eng. and Min. Jour., New York.

1911.

January	$39.03	July	$42.98
February	39.35	August	44.35
March	41.02	September	45.32
April	41.33	October	46.22
May	48.85	November	46.10
June	42.86	December	46.05

1912.

January	$46.00	July	$45.50
February	45.63	August	45.50
March	45.50	September	45.50
April	45.50	October	45.50
May	45.50	November	45.50
June	45.50	December	45.50

1913.

January	$45.50	July	$45.50
February	45.50	August	44.90
March	45.50	September	43.96
April	45.50	October	44.00
May	45.50	November	43.70
June	45.50	December	43.45

1914.

January	$43.38	July	$43.50
February	43.50	August	50.20
March	43.50	September	50.00
April	43.50	October	49.50
May	43.50	November	45.45
June	43.50	December	42.19

During 1914 the average price of the various platinum-group metals was approximately as shown below, which figures have been used by the United States Geological Survey in all computations.

Average price of refined metals of the platinum group in 1914.

Metal.	Per troy ounce.
Platinum	$45.00
Iridium	65.00
Iridosmine (osmiridium)	33.00
Palladium	44.00

No quotations of prices of the remaining metals of the platinum group—osmium, rhodium, and ruthenium—are available, and probably any sales were private. These metals are scarce and have little commercial use, and it seems probable that very small quantities, if any, were marketed in 1914.

PRICE OF CRUDE PLATINUM.

Domestic.—As stated in the report for 1913 the crude platinum concentrates produced in the placer fields of the United States contain, as a rule, some valueless sand grains; also the grains of the

metal itself are impure, carrying iron, gold, and silver. Ordinarily the valuable metallic content of the California sands is about 80 per cent by weight, but in 1914 some sands carrying as much as 85 per cent metal were produced. The Oregon sands are estimated to be 70 per cent fine. The proportion of the platinum metals recovered from crude sands in 1914 was about 51 per cent platinum, 3 per cent iridium, and 30 per cent iridosmine or osmiridium. The price received for domestic crude platinum in 1914 varied between $30 and $32 an ounce troy, the higher figure being accepted as most nearly representing the majority of sales.

Russian.—Russian crude platinum, which contains approximately 83 per cent metal, sold for about $35.50 an ounce at Petrograd up to July, 1914. No quotations are available for the remainder of the year. During 1915 Russian quotations ranged from approximately $30 at the first of the year to $32 in June.

According to reports[1] considerable crude platinum is now held by Russian banks, which advanced about 80 per cent of its value to the producers.

IMPORTS.

The following table shows the imports for consumption into the United States of platinum in 1905–1914:

Platinum imported for consumption into the United States, 1905–1914.

Year.	Platinum or crude platinum, and unmanufactured products, ingots, bars, sheets, and wires.		Manufactured products, including vases, retorts, etc.	Total value.
	Quantity.	Value.		
	Troy oz.			
1905	93,912	$1,985,107	$188,156	$2,173,263
1906	137,928	3,601,120	187,639	3,788,759
1907	74,292	2,508,991	175,651	2,684,642
1908	50,844	1,095,754	134,119	1,229,873
1909	118,853	2,557,596	416,352	2,973,948
1910	118,280	3,320,699	333,965	3,654,664
1911 Ore or crude	34,412	1,278,239	142,718	4,866,207
1911 Unmanufactured, etc	88,339	3,445,250		
1912 Ore or crude	45,280	1,781,585	169,119	4,503,682
1912 Unmanufactured, etc	59,526	2,552,978		
1913 Ore or crude	48,942	1,863,406	90,694	5,040,210
1913 Unmanufactured, etc	69,551	3,086,110		
1914 Ore or crude	30,304	1,092,327	46,533	2,908,353
1914 Unmanufactured, etc	39,781	1,769,493		

The great decrease in the imports of platinum is due to the unsettled conditions abroad. The embargo placed upon the export of platinum from Russia at the outbreak of the war resulted in greatly reducing the quantity of refined and manufactured platinum shipped from France and England, and the shipments from Germany apparently stopped. The decrease in imports of crude ore in 1914 from those of 1913 amounted to 18,638 ounces, or a little over 38 per cent; in unmanufactured platinum, ingots, and bars, the decrease was 29,770 ounces, or almost 43 per cent. The imports of manufactured plati-

[1] Min. Jour. (London), vol. 104, p. 180, 1914; vol. 108, pp. 171–172, 1915.

num ware dropped in value from $90,694 in 1913 to $46,533 in 1914, of more than 49 per cent.

The following table shows the imports for consumption into the United States of the remaining platinum-group metals in 1913 and 1914:

Platinum-group metals, except platinum, imported for consumption into the United States in 1913–14.

Metal.	1913		1914	
	Troy oz.		*Troy oz.*	
Iridium	4,094	$295,864	1,785	$112,430
Osmiridium	151	11,872	1,348	84,363
Osmium	560	42,924	.....	.....
Palladium	8,891	364,738	1,613	69,547
Rhodium	64	3,668	32	1,905

WORLD'S PRODUCTION.

The world's output of new platinum, 1911–1914, is given approximately in the following table:

World's production of new platinum in 1911–1914, by countries, in troy ounces.

Country.	1911	1912	1913	1914
Russia, crude	[a] 300,000	[a] 300,000	[a] 250,000	[a] 241,200
Canada, crude	[a] 30	[b] 30	50	[a] 30
New South Wales and Tasmania, crude [c]	470	[a] 778	1,275	[a] 1,248
Colombia, crude	[a] 12,000	[a] 12,000	15,000	[a] 17,500
United States, domestic crude	628	721	483	570
United States, refined from foreign and domestic matte and bullion [d]	[d] 1,200	[d] 1,300	[d] 1,100	2,905
Borneo and Sumatra and other crude [e]	.....	[a] 200	200	(*f*)
Total	314,328	315,029	268,108	263,453

[a] Estimated.
[b] In addition to platinum contained in matte and bullion refined in the United States.
[c] Chiefly iridosmine.
[d] Does not include refined platinum from domestic crude.
[e] Includes small production in Madagascar.
[f] No basis for estimate.

The estimation of the production of platinum in foreign countries for the calendar year 1914 is more difficult now than heretofore because little information concerning platinum developments has been published. The writer wishes to acknowledge his indebtedness for information concerning the production of various countries to Prof. G. A. Roush, editor of Mineral Industry; Mr. John McLeish, chief of division of mineral resources and statistics, mines branch, department of mines, Ottawa, Canada; Mr. Baliol Scott, editor of Mining Journal, London, England.

USES.

One of the most important uses of platinum is as a catalyzer in what is technically known as "contact mass" in the manufacture of fuming sulphuric acid and sulphur trioxide. There are several kinds of "contact mass," the two most used in this country being on asbestos or magnesium sulphate bases. The mass is made by soaking the base in solutions containing platinum chloride and afterwards heating it. This treatment results in a more or less complete distribution

of very fine particles of metallic platinum throughout the mass. Some "contact mass" contains as much as 7 to 8 per cent by weight of platinum, and other manufacturers make a mass containing as little as 0.2 per cent metallic platinum by weight.

It is impossible at this time to state the quantity of platinum used in the sulphuric-acid industry in this country, but it is believed that the loss of platinum in well-regulated practice is very small. The platinum does not enter into the chemical reactions, but rather acts as an exciter in the formation of sulphur trioxide, which, on combination with water, yields sulphuric acid.

Platinum dishes and utensils of many kinds are still a necessity in chemical laboratories and many chemical industries, but the use of this metal in the electrical industry is each year becoming less. In the manufacture of incandescent lamps a large quantity of platinum was formerly used, but at present wires made of nickel-chromium alloys or metallic tungsten or metallic molybdenum are used. The resistance wires of electric furnaces and heaters at one time contained considerable platinum, but metallic molybdenum has now to a considerable extent replaced the more expensive metal. Formerly the electrical ignition points of gas engines were made of platinum, but it is believed that most of the spark-plug points now used are made of metallic tungsten.

The dental industry once used a large quantity of platinum in making artificial teeth. It is understood that recently metallic molybdenum plated with platinum is widely used rather than pure platinum.

The art of platinum plating has now been perfected to so remarkable a degree that jewelers are no longer under the necessity of using so much platinum as formerly in making jewelry, though platinum is still considered the best setting for precious gems. This use of platinum, however, is somewhat subject to the reigning fashion. Of interest in this connection is a bill which was prepared by the National Jewelers' Board of Trade of New York early in 1914 for presentation to the New York Legislature, making it a misdemeanor to mark inferior jewelry "platinum," "pure platinum," or "solid platinum" unless it is 0.950 fine or contains 95 per cent platinum group metals.

A somewhat similar law was passed by the Swiss Federal Council, to be effective March 1, 1914.[1] This law provides that "upon request of the manufacturer, seller, or purchaser, articles having a minimum platinum content of 95 per cent will receive the official stamp of an Alpine goat."

NOTES ON THE PLATINUM INDUSTRY.

UNITED STATES.

CALIFORNIA.

The greater part of the platinum recovered in California in 1914 was obtained as a by-product from the dredges at Oroville and Folsom. It is possible that the recovery of platinum by these dredges may be somewhat increased in the near future by the use of jig sluices, such as that installed on the Yosemite Dredging & Min-

[1] Commerce Reports, No. 914, Mar. 25, 1914, p. 1128.

ing Co.'s boat.[1] Some platinum was obtained by hydraulic work and dredging in Trinity and Siskiyou counties, particularly on Klamath and Trinity rivers.

In April, 1915, an arsenical mineral, supposed to be sperrylite, was found in the gold ores of the Antrim vein of the Long Ton mine, located at Woody, Kern County. This vein is reported to occur in granite near an intrusive mass of granodiorite. The vein has been crushed, producing considerable blue clay gouge. The questionable mineral, separated from the concentrates, is said to be steel gray in color, heavier than the sulphide concentrate, and to occur in diamond shapes, in cubes, and in flat granules. A Bakersfield newspaper clipping received by the Survey gives details of the qualitative tests used to determine the mineral, but, as has been pointed out,[2] they do not seem to be conclusive.

Recently a report was received of the recovery of placer sands containing platinum and iridium from Beegum Creek, in the extreme northwest corner of Tehama County, but no verification of the discovery has yet been received.

NEVADA.

The discovery of platinum and allied metals associated with the copper-gold ores of the Boss mine, 10 miles west of Goodsprings, Nev., in August, 1914, was widely noted in technical publications and daily papers. In the report on platinum in Mineral Resources for 1913 considerable information was given to show the undoubted presence of platinum in so remarkable an occurrence.

Since December 1, 1914, the Boss mine has been operated under bond by the Platinum Gold Mining Co.

In October, 1914, the Boss properties were examined by Adolph Knopf, of the Geological Survey, whose report on this occurrence was published[3] April 12, 1915. As this report has already been widely distributed, it is thought necessary to give here only the following brief summary, kindly prepared by Mr. Knopf:

Platinum and Palladium in the Yellow Pine Mining District, Nevada.

By Adolph Knopf.

In 1914 platinum and palladium were found in certain ores of the Yellow Pine mining district, in Clark County, Nev. The first and by far the most important discovery was made at the Boss mine, and later in the year platinum was found also in the ore of the Oro Amigo mine.

The ore deposit on the Boss claim was discovered some 30 years ago, having been located for copper, the presence of which is plainly indicated by chrysocolla and other oxidized copper minerals. In the nineties a leaching plant was built at Goodsprings, 12 miles from the mine, and an attempt was made to treat the oxidized copper ore, but the process proved a failure. Not until recently was the gold and platinum content of the ore recognized. The failure to recognize, or at least fully to appreciate, the presence of gold in the ore seems to have been due to the facts that much of the gold is very finely divided and can not be obtained by panning, and that some of the very rich material yields on panning a black residue that was probably thrown away as worthless black sand. Systematic sampling of the deposit early in 1914 showed that the ore contains gold

[1] Neil, J. W., Application of jigs to gold dredging: Min. and Sci. Press, vol. 109, pp. 839–842, 1914.

[2] Eng. and Min. Jour., vol. 99, p. 1045, 1915.

[3] A gold-platinum-palladium lode in southern Nevada: U. S. Geol. Survey Bull. 620, pp. 1–18, 1915 (Bull. 620–A).

in valuable quantity, and it was in the course of this sampling that the platinum and palladium content of the ore was discovered.

The deposit at the Boss mine consists of a fine-grained quartz mass, which in the main replaces iregularly the Carboniferous dolomites along a series of vertical fractures. A small mass or dike of granite porphyry intrudes the dolomite about 600 feet north of the mine, but no basic intrusives occur; in fact, none are known to occur in the Yellow Pine mining district, which is the most productive lead-zinc district in Nevada. The ore bodies so far developed may be briefly described as oxidized copper shoots and gold-platinum-palladium shoots. The copper ores consist largely of chrysocolla and other oxidized compounds, but these ores carry only minor quantities of the precious metals. The gold-platinum-palladium shoots consist of a fine-grained quartzose ore containing a small quantity of a bismuth-bearing variety of the rare mineral plumbojarosite (a hydrous sulphate of iron and lead). The principal ore shoot disclosed by the present workings forms an irregular pipe, pitching at a low angle to the northeast. In this shoot, at the time of visit, from 1,000 to 2,000 tons of ore had been developed, which averages, in ounces to the ton, gold, 3.46; silver, 6.4; platinum, 0.70; and palladium, 3.38. The precious metals are associated especially with the plumbojarosite; pockets of the pure mineral carry 100 ounces or more of platinum and palladium and several hundred ounces of gold to the ton. This great richness points to a concentration of the precious metals in the oxidized ore by surface solutions, so that in depth the pockets of extremely high-grade ores, such as are now being extracted, will give place to ore of moderate grade. The only sulphide so far found in the mine is chalcocite, and this is probably of secondary origin.

The gold-platinum-palladium deposit at the Boss mine differs greatly from any described deposit carrying platinum metals. Further, its probable genetic connection with siliceous igneous rocks is very remarkable, for most primary platiniferous deposits are genetically associated with basic igneous rocks. The Boss lode is one of the few primary deposits in which platinum metals occur in more than traces, and with one possible exception (the new Rambler mine in Wyoming) is the only primary deposit of economic importance in which these metals are the constituents of predominant value.

OREGON.

The larger part of the platinum obtained in Oregon in 1914 came, as usual, from beach workings in the vicinity of Bandon, Bullards, and Marshfield, though some was obtained in hydraulic workings near Galice, Kerby, and Waldo. No new discoveries of platinum of importance were made in this State in 1914. The Sweet machine is in use at several properties and from all reports appears to be making satisfactory recoveries. It seems probable that 1915 will witness decidedly larger operations in Oregon.

WYOMING.

At the Rambler mine in Albany County, Wyo., little new ore was raised in 1914, but the 50-ton mill was rebuilt and a Peck centrifugal concentrator was installed[1] during the latter part of the year. It is understood that some ore from the bins was put through this machine and that a satisfactory saving of platinum and palladium was accomplished.

FOREIGN.

COLOMBIA.

As stated in the report for 1913, the principal platinum producing region in Colombia is on Atrato and San Juan Rivers and their tributaries in the Choco district. Late in 1914[2] an English company se-

[1] Min. and Eng. World, vol. 41, p. 1155, 1914.
[2] Eng. and Min. Jour., vol. 98, p. 861, Nov. 7, 1914.

cured concessions for working a large area of platinum gravels in this district. Later it was reported [1] that the Anglo-Colombian Development Co. had nearly completed a dredge on Condoto River and expected to begin working within a short time. The report states that sanitary precautions have been taken in the construction of the town and shops of this company, located at the junction of San Juan and Condoto rivers. The prevalence of fever in the Choco district is well known, and if foreign labor is to be successfully used every sanitary precaution must be taken.

The same correspondent states that prospecting by drill on the Opogodo property of the Colombian Gold & Platinum Syndicate (Ltd.), had already proved 1,000,000 cubic yards of gravels, carrying platinum, iridium, osmiridium, and gold to the value of $0.50 a cubic yard.

GERMANY.

The discovery of platinum in Westphalia in December, 1913, caused considerable excitement and no little discussion. In view of the fact that the matter received widespread notice the following extracts from an article by Prof. P. Krusch [2] may be of interest to those who are engaged in the industry.

During the last year the Royal Geologic Society of Berlin has begun a special geological survey of the district. This specialized map brings out the fact that the oldest platinum-bearing formation known to date belongs to the "Gedinnien," and may therefore have to be reckoned as Silurian. Following this we note a series of most varied horizons irregularly distributed up to the uppermost middle Devonian, where the shales are still subject to mineralization. The distribution of platinum is closely dependent on the stratigraphy and structure of the district.

In such districts as I have examined the slates and graywacke formations play the main part. Platinum has been found in diabase and basalt, but as I have not determined this, I will restrict myself to the former formations. In isolated instances the slates have carried more platinum than the graywacke. The Siegerland miner lays great stress on the cropping of graywacke. * * *

I have made a microscopic study of the platinum-bearing graywacke formations. The normal graywacke is an elastic rock which consists mainly of quartz and slate, which is bound with a clay cement. It is therefore made up of the fragments of other rocks. The fragments were laid in water with imperfect separation by specific gravity. Frequently the graywacke contains feldspars which are partly kaolinized. Denckmann found such conglomerate with distinct granite pebbles. * * *

The microscopic study reveals that the cement of the rocks is not merely clayey or siliceous, but is also carbonaceous. The younger formations, bearing platinum, gold, or zinc, are distinguished by the cement regardless of geologic age. While the majority of the younger sediments are of loose texture, the graywacke are really cemented.

The platinum-bearing beds belong to the marine sediments. * * * As a result of microscopic investigation, it is safe to say that the ore minerals are partly concentrated in the cement and are more rarely found in the fragments which have been recemented to form the graywacke. * * *

Of great interest are the occasional gold particles found in the slides. They are extremely small and are found in the cement. This appearance of gold was not surprising to me. With high magnification, 240 to 1, small black scales can be seen in the cement, very seldom in the quartz. It is impossible to tell anything about them under the strongest power. They are easily distinguished from the coarser graphite scales which are seen occasionally. They frequently show crystalline structure. By very fine grinding it is often possible to float these specks on water. Up to now I have not gathered enough of them to make

[1] Min. Jour. (London), vol. 108, p. 157, Mar. 6, 1915.
[2] Krusch, P., The platinum deposit of Germany's Paleozoic (Trans. by F. Sommer Schmidt); Min. and Sci. Press, vol. 109, pp. 879–881, Dec. 5, 1914.

a platinum determination. Among the material that floated was graphite, sericite, mica, and gold. As I did not find any other platinum-bearing ore in the graywacke, I am forced to assume that the precious metals are associated with these specks, particularly as they are found especially in the cement. What is more striking is that these specks are sometimes found in the quartz. * * *

Of particular value to the investigation of the origin of the graywacke fragments is the segregation of certain constituents. Pufahl has treated 200 grams of finely ground pulp for weeks with hydrofluoric acid and concentrated sulphuric acid. After the first attempt, there was still quartz in the residue, while after a second trial the residue was free from quartz. The insoluble consisted of 0.044 gram of heavy precious metal residue and disintegrated chrome iron ore. With this precious metal residue there was considerable zircon, with its characteristic radioactive rays. In one residue a small amount of platinum was determined which figured on 1 ton of residue would amount to 1.15 grams. The extraction was made in a platinum crucible and it is not impossible that it may have been derived from that source. * * *

Pufahl determined the presence of the following metals in the ore: Cr, Pt, Ir, Fe, Au. Hommel determined Cr, Ni, As, Sb, Fe, Cu, Pb, Zn, Ag, Au. In this aggregate it is well to separate the earlier ones from those that came later. The later ones would be Cu, Pb, Zn, As, Sb, Ag. The original ones are probably Cr, Ni, Fe, Pt, Ir, Ag, Au. The later minerals are probably derived from basic eruptives. Until now it has been impossible to get any idea as to the origin of the platinum or its chemical combinations. * * *

The principal production of platinum is in the Urals and a little from British Columbia, in which regions the deposits result from the destruction or disturbance of primary deposits re-formed through the agency of water. While the mineral is not in commercial quantity in the primary deposit, the distribution of the mineral in the secondary deposits has permitted commercial extraction. A comparison of these well-known deposits with the newly discovered ones in the Rhine slates shows that the platinum in these latter show the same chemical association as the primary deposits in the Urals and British Columbia. One is practically forced to the conclusion that in the Rhine slates the origin is connected with a basic eruptive, probably peridotite. To differentiate the platinum-bearing graywacke from the Ural and Canada formations, it can be said that they have a great geologic age and were consolidated by a cement.

The granite pebbles in the conglomerate point to the existence of the granite in depth. They belong to the basal formation which is overlain by the graywacke to an unknown extent. This basal complex could also contain the platinum-bearing basic eruptives and the primary gold. The sea during Silurian and Devonian times disturbed this basal complex and transported the precious metals into certain definite strata. Later these platinum-bearing beds were again partly disintegrated and the fragments cemented in younger, higher horizons. This explains the wide distribution of the precious metals through so many horizons. They are the product of continual destruction of older beds and the building of new sediments. * * *

As this is a matter of precious metals, I will depend only on my own sampling and tests. I used the greatest care, taking 2-kilogram samples, which were lead sealed in boxes on the spot. In addition to these, I took larger samples weighing from 20 to 40 kilograms and put [them] in the usual sacks. As I could not give these sacks the attention I desired, I only lay stress on them in so far as they agree with the sealed samples. In testing this material it is necessary to use a fine mesh, namely, 280 to the inch. From my experience it is desirable to use the largest possible quantity of pulp. In the dry work never less than 200 grams, and preferably 300 grams, should be fused. In the wet methods 1 kilogram should be used. If platinum tests are made in different laboratories, or if the same test for platinum is made in the same laboratory several times, surprisingly divergent results will be obtained. For example:

	Grams per ton.
First test:	
Laboratory A	30
Laboratory B	Trace.
Second test:	
Laboratory C	33.5
Laboratory D	3.8
Third test:	
Laboratory E	8.0
Laboratory F	.8

To determine the cause of these great discrepancies requires most painstaking investigation. It used to be believed that the platinum of the graywacke behaved abnormally while the precious metals were in the gel form in the rocks. The first one to advance this theory was Schreiber, the discoverer of platinum in the Siegerland. He has doubtless some justification for this assumption, because, first, the gels have the property of appearing in finest division in the rocks, and, second, colloidal platinum solutions are known. The question whether a precious metal occurs as a gel can not be answered by a chemist but rather by a petrographer, because the gel is easily distinguished optically from crystalline bodies, and this can not be done chemically. Schreiber was really in error when he assumed that the difficulty in platinum chemistry had something to do with the gel form. If platinum is in the gel form, this can work no hardship on the chemist with the dry method, because gel is converted into the crystalline form by great heat. As it is possible to distinguish minute crystal fragments in the black specks, it is probable that in this case it is not a question of gels but of crystalline structures. * * *

There must therefore be some other reason for this discrepancy in results. It is either an error in analytical method or the original distribution of platinum in the rock. I am loath to admit any possibility of error in the chemical work. I am inclined to agree with Pufahl that the irregular distribution of the metal, in spite of the great fineness and the most careful mixing, is accountable for incorrect averages. We are already acquainted with similar cases. * * *

It is, then, impossible to establish the average in this way. The practical inference from all this is that we can only depend upon actual production which is capable of being demonstrated on a small scale for experimental purposes. Only the most exacting tests on samples of 1 ton and the extraction of the contained platinum can guard us against error.

RUSSIA.

There is a dearth of information concerning operations in the Russian platinum fields during 1914. During ordinary years the London Mining Journal contains a number of contributions on Russian platinum, but very little news for 1914. Before the outbreak of the war the feeling was strong that Russia would produce as much, if not more, platinum in 1914 than for several years, owing in part to new dredging ventures and in part to the owners permitting more work under the leasing system. From the published figures of production this expectation was not realized.

Production of platinum in Russia, 1900–1914, in fine ounces.

Year.	Official.	Estimated total.	Year.	Official.	Estimated total.
1900	163,060	212,500	1908	156,792	250,000
1901	203,057	315,200	1909	164,118	264,000
1902	197,024	300,000	1910	175,716	275,000
1903	192,976	226,000	1911	180,400	300,000
1904	161,950	290,120	1912	177,375	300,000
1905	167,950	200,450	1913	173,642	250,000
1906	185,792	210,318	1914	156,775	241,200
1907	172,752	310,000			

The most important event in the Russian situation was the placing early in the year of a 30 per cent ad valorem export duty on crude platinum.[1] The value of crude platinum under this law is to be fixed by the council of ministers, and it is thought that it will produce a revenue of approximately $2,000,000 a year. The law was apparently passed with the expectation of bringing platinum

[1] Min. Jour. (London), vol. 104, p. 180, Feb. 21, 1914.

refiners to Russia, but up to the present it has evidently failed of its purpose. The passage of this law has finally put an end to the question of a government monopoly of platinum mining.

Soon after the beginning of the war the Russian Government issued an order forbidding the exportation of raw platinum in quantities valued above 500 rubles ($257.50). It was apparently believed that these two measures would result in the establishment of refineries in Russia. This expectation was not realized, according to a recent consular report,[1] which comments under the heading, "Russian gold and the platinum situation," as follows:

At the meeting of the Russian Export Chamber on May 11, 1915, a report was presented on the work of the newly organized bureau for the gold and platinum industries, which has over 20 members. Some time ago an order was issued forbidding the exportation of raw platinum in quantities valued above 500 rubles ($257.50), in order that domestic refineries of the metal might be encouraged. However, not a single refinery has been opened, and the producers of platinum now have the metal on their hands and are unable to sell it. They have requested the bureau to find out whether or not sales of platinum might be organized in the United States. In case of an affirmative answer, the producers will ask for a modification of the embargo.

On the other hand, there can be little question that large stocks of crude platinum have accumulated in the Russian centers, particularly Petrograd and Ekaterinburg. An interesting side light on this situation is given in the London Mining Journal:[2]

The situation created by the present war would have formed an excellent opportunity for British platinum buyers to start an indirect business in the Urals—i. e., buy direct from the Russian producers. To thoroughly understand the full advantages of this exceptional occasion it must be remembered that up till the war the French company (Compagnie Anonyme) always had a predominating interest in the platinum business, which practically amounted to a monopoly, having entered into agreement with the chief big producers for the exclusive purchase of their ware, besides being large producers themselves. Since the outbreak of the war, however, the French company have naturally been unable to meet their obligations of purchase, with the result that their former clients have been obliged to resort to the only way out of the difficulty, viz, mortgage their ore with the banks here. If a strong British organization was to come along provided with sufficient financial strength, there is little doubt but that it could take up a monopolizing position in the platinum industry of the Urals, and it must be remembered that such a monopoly really means being in a position of dictating prices. The greatest difficulty, however, would seem to be the flatness of the demand on the markets abroad; however, owing to the reduced prices prevailing here now, a strong financial group could well afford to wait till better times for selling their ore. One thing is, however, certain, and that is that if the British do not make a bold move while they have the opportunity there is no doubt that after the war the possibility of getting a firm footing and direct business with the producer here will be lost, and they will again have to depend on buying refined platinum at an enhanced price in Paris.

The price prevailing now for small quantities of platinum ore—i. e., from the small producers—is between 8 rubles[3] and 8.50 rubles per zolotnik on an 83 per cent basis platinum, * * * but all the available platinum at this price is being bought up by local speculators, who are reselling to Petrograd at prices commencing at 9 rubles per zolotnik and over.

Considerable stocks are lying mortgaged at the various banks here (not less than 80 poods).[4] The output for the current year is estimated to be very much less than for former years.

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[1] Commerce Repts., No. 139, p. 1211, June 15, 1915.
[2] Vol. 109, p. 445, June 19, 1915.
[3] Ruble=$0.515; 1 zolotnik=65.8329 grains troy.
[4] One pood=526.6632 ounces troy.

TASMANIA.

Osmiridium has been found in the following places in Tasmania: Savage River, Heazlewood River, Whyte River near the junction with the Pieman, Badger gold diggings west of Savage River, Castray River, Huskisson River, Wilson River, Salisbury goldfield near Beaconsfield, tributary of Fourteen Mile Creek near Tyenna, Boyes River (flowing into the Gordon below the Great Bend), and Bald Hills.

The production of iridosmine from the Bald Hills district, near Waratah in the northwestern part of Tasmania, began about 1900, and has shown a steady increase. The district has been described recently in an official publication,[1] a summary of which is given below.

The Bald Hill district is situated in the northwestern part of the island north of the road from Waratah to Corinna, about 19 miles west of the former town. To reach the district the main road to Corinna is followed to the saddle known as "Nineteen Mile," from which place a foot track is followed northward for a mile to the district.

Bald Hill forms the divide between Nineteen Mile Creek and Heazlewood River and is at the northeastern end of the Long Plains, which are believed to be part of an extensive peneplain, in which the streams have cut their present courses in comparatively recent times. The general level of the higher parts of the peneplains and of Bald Hill is 1,600 feet above the sea level. The greater relief of Bald Hill is due to the hard siliceous lodes which outcrop on its summit.

This hill is at the north end of a belt of serpentinized rocks, which is 2 to 4 miles wide and 30 miles long north and south and lies on the east side of the Meredith Mountains. The peridotites and pyroxene rocks have been intruded by granite, but both types are thought to be of Devonian age. The Basic rocks have intruded pre-Silurian and Silurian slates and sandstones.

The peridotites and pyroxenites are said to represent basic developments of the gabbroid magma, and where least serpentinized are composed of bronzite, enstatite, and olivine. Serpentinization has progressed far, however, in most places. The metallic minerals of the serpentines, probably primary minerals of the basic rocks, are magnetite, pyrite, pyrrhotite, nickel, gold, and osmiridium.

Osmiridium has been mined from placer deposits in Nineteen Mile Creek and its tributaries, Linger-and-Die, McGintys, and Barren creeks, and from Savage River for some distance below the mouth of Nineteen Mile Creek. This metal has also been found in the rocks of Bald Hill, particularly in certain belts of altered serpentine, and also in association with chalcedony and opaline silica in lode-like forms.

Concerning the origin of these veins, Twelvetrees makes the following statement:[2]

> The whole question of the origin of these veins of chalcedony and opaline silica is full of interest. It is probable that they have been formed in the rock joints as the result of solutions started in the serpentine by the expiring action of the magma. On this hypothesis the cooling and attenuated aqueo-siliceous solutions filtered into existing joint fissures, and might possibly involve mechanically small quantities of osmiridium and other minerals during their passage.

[1] Twelvetrees, W. H., The Bald Hill osmiridium field: Tasmanian Dept. Mines, Geol. Survey Bull. 17, 1914.
[2] Op. cit., p. 19.

The veins of pyrrhotite which intersect the serpentine which is associated with these lodes must be of magmatic origin, and the serpentine is so intimately mixed with the siliceous and metalliferous veins that mere assay results may be misleading when one seeks the precise derivation of the osmiridium obtained. The latter may be genetically connected with the serpentine which is traversed by the veins, and not with the veins themselves. This is probably the case, as osmiridium must have separated out from the magma as one of the earliest minerals.

The placers of Savage River were worked for gold as early as 1884, and when the price of osmiridium rose in 1899 the miners began to save this material. It was found that the osmiridium came from the streams heading in Bald Hill, and it was later shown that it came from the serpentine.

The osmiridium, in some deposits coated with iron oxide, in others inclosed in grains of chromite, is not always recognizable in the pan until cleaned with acid. A peculiarity of the Tasmanian material is that it contains almost no platinum, as shown by the following analysis, published April 3, 1914, as an addendum to the report of Mr. Twelvetrees.

Results of examination of half an ounce of osmiridium grains.

1. *Mineralogical.*—The sample consisted of loose metallic grains, varying in color from tin-white to yellowish gray. Half of the grains averaged about 1 millimeter in diameter and the remainder about one-half millimeter.

2. *Chemical.*—

	Per cent.
Platinum (Pt)	0.37
Ruthenium (Ru)	8.19
Palladium (Pd)	.21
Gold (Au)	.04
Iron (Fe)	.30
Copper (Cu)	Trace.
Iridium (Ir) and rhodium (Rh)	33.80
Osmium (Os) (by difference)	57.09
	100.00

3. *Commercial valuation and remarks.*—The above analysis indicates that the sample consists of iridosmine (siserskite), in which the amount of osmium present is considerably in excess of the iridium, the reverse being usually the case in the analysis of iridosmium from other sources already on record.

Some additional details of the Tasmanian osmiridium fields were published late in 1914,[1] but the Government geologist's report described the principal features of this interesting district.

DETERMINATION OF PLATINUM.

Since the unexpected and remarkable discovery of platinum in the ore of the Boss mine in Nevada there has doubtless been more interest in prospecting for this metal in lode deposits than ever before. The assay for platinum, as is well known, is a delicate and difficult matter, and not all assayers are thoroughly familiar with its technic. It is possible, therefore, that some persons have been misled by incorrect analysis of materials into the belief that they have workable platinum lodes. On the other hand, platinum may be present, but not recognized. In order to distribute more widely information concerning

[1] Dunn, E. J. Tasmanian osmiridium fields: Australian Statesman and Mining Standard, Dec. 24, 1914, pp. 539–540.

the chemical determination of platinum and allied metals the following articles[1] by Mr. A. M. Smoot, chief chemist of Ledoux & Co., New York, are published in full:

DETERMINATION OF PLATINUM, PALLADIUM, AND GOLD.

By A. M. Smoot.

Scorify the lead buttons from two or more ½-a.t. crucible fusions together, adding at least six times as much silver as the combined weight of the Pt, Pd, and Au present, and cupel *hot*. In rich materials, such as slimes or concentrates, two ½-a.t. fusions suffice, but low-grade ores may require 10 or more ½-a.t. fusions combined for each determination.

Part the silver beads with HNO_3 (1:6), followed by stronger parting acid (1:1) and wash with water as usual. All Pd goes into solution, together with considerable Pt. The residue consists of Au plus some Pt. Dissolve residue in strong aqua regia and reserve the solution (solution *A*). Precipitate the silver in the nitric-acid solution—containing Ag, Pd, and some Pt—with HCl. Practically all the Pt will remain in solution; but the precipitated AgCl is pink and contains considerable Pd. Filter off the AgCl, scorify and cupel it and part again with HNO_3 (1:6); all should dissolve. Reprecipitate the Ag with HCl. The liquid now contains most of the remaining Pd, but some is coprecipitated with AgCl. Filter off the AgCl and add the filtrate to the first filtrate from AgCl. Again scorify and cupel the silver chloride, dissolving the silver in nitric acid as before and reprecipitating the silver as chloride. In most cases the filtrate from this silver chloride contains all the remaining Pd. If, however, the AgCl is distinctly pink, another separation must be made.

Unite all filtrates from AgCl precipitations and evaporate to small bulk, adding the aqua-regia solution of the Au and Pt (solution *A*). The liquid now contains all the Au, Pt, and Pd present in the original ore, together with traces of Ag due to solubility in AgCl in excess of HCl, and also traces of Pb gathered from the lead retained in the silver buttons from the several recupellations.

Evaporate the liquid to dryness on the steam bath; take up with dilute HCl (1:3) and evaporate again to dryness; take up with five drops of HCl and 40 c.c H_2O. Pay no attention to any insoluble residue of AgCl or $PbCl_2$.[2] Precipitate gold by adding, say, 3 gm. of oxalic acid to the solution and boiling it. Let stand overnight and filter off the Au. If Pt and Pd are high, it is necessary to redissolve the Au in aqua regia, evaporating with HCl to dryness and repeating the oxalic-acid precipitation, uniting the filtrate with that from the first gold precipitation. Burn the filter containing the gold and scorify it with six times its weight of silver and a little test lead; cupel, part, and weigh the gold as usual.

To the oxalic-acid filtrates from Au add 5 c. c. of HCl and make volume up to 150 c. c.; heat to boiling and precipitate Pt and Pd with a rapid current of H_2S in *hot* solution, passing the current of gas for some time and keeping the solution hot during precipitation. Filter and wash the Pt and Pd sulphides with H_2S water containing a little HCl. Wash the precipitate from the filter with a fine water jet into an original beaker; spread the filter paper (which will contain a small amount of precipitate impossible to wash off) with the precipitate side down over the lower side of a watch-glass cover. Add aqua regia to the precipitate in the beaker and place the cover on the beaker; warm gently to dissolve the Pt and Pd sulphides. The fumes arising from the acid dissolve the traces of Pt and Pd adhering to the filter paper. When solution is complete and the filter paper is white, remove the watch-glass cover and wash the paper with hot dilute HCl thrown against it in a fine stream.

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[1] Eng. and Min. Jour., vol. 99, pp. 700–701, Apr. 17, 1915.

[2] In materials rich in palladium the small amount of $AgCl + PbCl_2$ may be distinctly pink in color and retain weighable quantities of Pd. If this is the case, the Pd may be recovered in the solution from the nitric acid parting of the gold. To do this, precipitate the silver in this liquid by adding HCl, filter off the silver chloride and evaporate the filtrate to dryness. Take up with a drop of HCl and a little water, let stand overnight and filter through a very small filter. This liquid may be added to solution B before precipitating palladium with glyoxime.

Evaporate the aqua-regia solution to dryness, take up the residue with HCl and evaporate again to dryness to remove all HNO_3. Take up the residue with two or three drops of HCl and about 2 c. c. of H_2O. The solution is usually perfectly clear, but it may be slightly cloudy owing to the presence of a little AgCl in it. No attention need be paid to this, however. Add 5 to 10 c. c. of a saturated solution of NH_4Cl, stir well and allow to stand over night. Platinum is precipitated as ammonium-platinum chloride—$(NH_4)_2PtCl_6$. Filter and wash the precipitate with 20 per cent NH_4Cl solution. All Pd passes into the filtrate which is reserved (solution *B*). Dissolve the Pt precipitate in boiling hot 5 per cent H_2SO_4; heat the liquid to actual boiling and precipitate with H_2S as before, filtering and washing with H_2S water. Burn the filter and precipitate at a low temperature in a scorifier; add six times as much Ag as Pt, scorifying with lead, cupel and part the silver bead containing the platinum with H_2SO_4; decant off the silver solution and wash once with strong H_2SO_4, followed by 50 per cent H_2SO_4, until practically all silver is washed away; finally wash with water, anneal, and weigh. A minute quantity of Ag is retained with the platinum, but it can usually be neglected. In very important work, where the amount of platinum is large, dissolve in aqua regia, evaporate the solution to dryness, take up with a drop of HCl, dilute largely with water, and let the AgCl settle over night; filter on a small paper, cupel it with a little sheet lead, and deduct the weight from the weight of platinum. This refinement need not be considered in materials running less than 15 or 20 ounces to the ton.

It may seem an unnecessary step to precipitate the platinum as sulphide, scorify it with silver, and part it as described in the foregoing. General practice has been to ignite the ammonium-platinum-chloride precipitate and weigh the metallic residue. When this is done, however, there is danger of losing considerable platinum, which is carried away mechanically during the decomposition of the compound; furthermore, it is extremely difficult (if not impossible) to collect the finely divided residue for weighing, and the precipitate invariably contains lead and silver. Precipitation as sulphide, scorification, and cupellation with excess silver and parting with sulphuric acid overcome the difficulties inherent in handling the ammonium precipitate.

The palladium is all contained in the filtrate and washings from the platinum-ammonium-chloride precipitates (solution *B*). Add to this solution at least seven times as much di-methylglyoxime as there is Pd present (in any case, at least 0.1 gm. glyoxime). The precipitant should be dissolved in a mixture of two-thirds strong HCl and one-third water. Dilute the liquid to 250–300 c. c., heat on a steam bath for half an hour and let stand over night. Pd is precipitated as a voluminous, yellow, easily filtered glyoxime compound $(C_8H_{14}N_4O_4)_2Pd$, containing, when dried at 110° C., 31.686 per cent of Pd. Filter the Pd precipitate on a weighed Gooch crucible and wash it, first, with dilute HCl, half-and-half, then with warm water and finally with alcohol; dry it at 110° to 115° C. and weigh. The disadvantage of weighing palladium on a Gooch crucible is overcome—at least to some extent—by the fact that the Pd compound contains a relatively small amount of Pd—less than one-third of its weight. This compound may also be weighed on carefully counterpoised papers; but it is better to use Gooch crucibles, if they are available, because of the relatively strong acid which is required for washing. The object in using half-and-half hydrochloric acid as a wash liquid is to dissolve out any excess of the glyoxime precipitant. This is easily soluble in moderately strong HCl, but is substantially insoluble in water.

DETERMINATION OF SILVER IN ORES AND CONCENTRATES CONTAINING PLATINUM AND PALLADIUM.

By A. M. Smoot.

Make the usual crucible fusion on one-quarter, one-half, or full assay ton, according to the amount of silver present. Instead of cupeling the lead button, hammer it free from slag and dissolve it in dilute nitric acid. Most of the silver passes into solution together with palladium, and perhaps a trace of platinum; but gold and most of the platinum remain insoluble. The gold and platinum retain an appreciable proportion of silver which can not be washed out. Filter out the insoluble residue and wash it thoroughly with hot dilute nitric

acid, followed by hot water. Scorify the residue once more with a little lead and dissolve the lead button as before, filtering into the beaker containing the first filtrate. In this liquid precipitate the silver as AgCl by adding standing NaCl in sufficient quantity; stir well, and if the amount of silver is small, add about ½ c. c. of strong H_2SO_4 to form a precipitate of lead sulphate. Let the silver chloride, or the silver chloride plus lead sulphate, settle over night or until the supernatant liquid is clear; filter through double filter papers; ignite and scorify the residue of silver chloride with test lead.

If the amount of palladium contained in the sample is small, the silver bead obtained by cupeling the lead button obtained by scorifying the silver chloride may be considered as sufficiently pure for ordinary purposes. It contains, of course, some palladium, and in accurate silver determinations the lead button from the first silver-chloride precipitation should be redissolved and the silver reprecipitated, filtered, and scorified as before. The amount of palladium retained after the second precipitation and scorification is so small as to be negligible.

As the method described above does not give details for the determination of all the platinum-group metals, the following paper by Mr. Martin Schwitter, chief chemist of Goldsmith Brothers' Refinery Co.,[1] of Chicago, is also quoted in full:

THE ASSAY OF CRUDE PLATINUM.

By Martin Schwitter.

Crude platinum is on the market in the shape of small nuggets, ranging in weight from 100 mg. down. It may be divided roughly into two portions, the insoluble and the soluble in aqua regia. The insoluble includes osmiridium as its only valuable constituent, while the soluble includes platinum, iridium, palladium, rhodium, and gold. It is desired to determine each of the above metals with accuracy.

This original method is now in use by a large buyer of crude platinum and has been checked up by results obtained in refining the purchased lots of crude.

The method.—Weigh 25 grams of the sample into a 300 c. c. beaker. Add 200 c. c. of aqua regia (1 part nitric to 3 parts hydrochloric acid, by volume) and place on the water bath for about one hour, then place on a thin piece of asbestos on the hot plate and boil gently for two hours. Remove from the hot plate and allow to settle for 15 min. Decant the solution into another 300 c. c. beaker and again boil for about an hour to dissolve any finely divided metal which may have decanted over. Remove from the hot plate and fill up the beaker with water. Stir well, then settle over night. Immediately after decanting the aqua regia from the original beaker, add another 200 c. c. of aqua regia to the residue therein and repeat the warming and boiling of the acid. Finally remove from the plate, fill with water, stir, and let settle overnight. Unless the ore is in unusually large pieces, the solution of the soluble minerals will be complete with this treatment, which is planned to take one day.

Decant the clear solutions from both the beakers into a 1,000 c. c. volumetric flask, being careful not to allow any of the insoluble to be carried over. Wash the contents of one of the beakers into the other so as to have everything in one beaker and to dilute the acid before filtering. Filter through a 9 c. c. paper into the 1,000 c. c. flask. Wash the insoluble from the beaker onto the paper and then wash on the paper till the solution which runs through is perfectly colorless.

Determination of osmiridium.—Transfer the filter paper and its contents to a 2½ in. scorifier, add 10 to 15 grams of test lead, fill the scorifier level full with litharge, and fuse in the muffle for ½ hour. Allow the scorifier to cool, break it, and remove the lead button. Clean the lead button thoroughly with as little hammering as possible, place it in a 150 c. c. beaker and dissolve out the lead with dilute nitric acid (1 vol. nitric acid to 3 vol. water). Place on the water bath to assist solution. When the lead has been all dissolved, filter through an ashless filter and wash the residue of osmiridium on the filter till free from lead. Dry the filter, separate the osmiridium from it as completely as possible, and burn the filter paper. Add the osmiridium to the residue from the paper, dry thoroughly on the hot plate and weigh as osmiridium.

[1] Eng. and Min. Jour., vol. 97, pp. 1249–1250, June 20, 1914.

The scorification with lead is for the purpose of cleaning the osmiridium from sand, heavy oxides, etc. The osmiridium is collected by the lead and the impurities are slagged off. Some care is required in igniting the residue, as osmiridium will lose osmium if heated to redness in the air. For this reason the paper is burnt after separating from the osmiridium.

Determination of platinum.—Fill the 1,000 c. c. flask containing the solution of the ore to the mark. Mix thoroughly by pouring into a dry beaker and back into the flask four times. Taking a 25 c. c. pipette, which has been carefully standardized against the 1,000 c. c. flask, rinse it out with a portion of the solution and then pipette two portions to 75 c. c. beakers. Evaporate these portions just to dryness on the water bath. Add to each 5 c. c. of dilute hydrochloric acid (1 acid: 9 water) and warm for five or 10 min. Allow to cool and unless perfectly clear filter through 5½ cm. papers into similar beakers. Wash with water till the filter papers are perfectly colorless. This can be done easily with less than 20 c. c. of water.

Make up each portion so that it contains about 25 c. c. Add to each 8 grams of c. p. ammonium chloride and heat on the water bath for one hour with occasional stirring. Remove from the bath and let stand at least three hours, or over night if convenient. Decant the clear solutions through a 9 cm. ashless filter into 150 c. c. beakers. Allow all the solution to run through and then wash the precipitates of ammonium chlorplatinate, $(NH_4)_2PtCl_6$, onto the filters with a 20 per cent solution of ammonium chloride. Allow all the solution to run through and then wash repeatedly around the edge of the papers with small quantities of the ammonium-chloride solution till the filtrate is colorless and the papers are white. Finally rinse around the edge of the papers with alcohol. After all the solution has run through place the filters with their points down into size B Battersea annealing cups. Carefully fold over the edges of the papers so as completely to inclose the precipitate in an envelope of paper. Cover the crucibles and bring to a good red heat by very slowly increasing the temperature. Finally remove the covers from the crucibles till the papers are burnt off. After cooling, transfer the platinum to the pan of the assay balance and weigh. (The duplicate should not vary more than two milligrams. The average is taken as correct.)

The precipitation of $(NH_4)_2PtCl_6$ is usually made with the addition of alcohol to reduce the supposed solubility of the precipitate. I am sure that by the above method I can take 0.0004 gram of platinum in the given size solution, 25 c. c. precipitate it, wash with the usual quantity of wash solution, and get back more than half of the original platinum. The solubility under the conditions given is negligible for this assay.

The solutions are heated on the water bath for two reasons: First, to get all the ammonium chloride rapidly into solution and, second, to change the precipitate from an amorphous to a sandy, crystalline precipitate, which is easily filtered and washed.

The precipitate of platinum usually contains iridium as $(NH_4)_2IrCl_6$. Iridium alloyed with platinum in small quantities, less than 10 per cent, dissolves with the platinum in aqua regia. It precipitates with the platinum, but not quite so completely. The traces which pass the precipitation are afterward estimated with rhodium.

Pure $(NH_4)_2PtCl_6$ is a pure yellow. The iridium compound has an intense red color. If $\frac{2}{10}$ per cent of iridium is present it gives a decided red tint to the platinum precipitate. The quantity of iridium present, if not more than 5 per cent, can be judged by the color of the precipitate quite accurately enough for setting a value on the ore.

There is a slight loss in igniting the platinum precipitate. This loss is lessened by keeping inclosed in the filter paper and by slow heating.

Determination of gold.—Combine the filtrate from the platinum precipitation and add 5 grams of ferrous sulphate in water solution plus HCl. Allow to stand till the gold has settled. Filter and wash on the filter, transfer to an annealing cup, and burn off the paper in front of the muffle. When cool, wrap in lead foil and cupel as usual for gold.

Determination of palladium.—Add to the filtrate from the gold about $\frac{1}{5}$ its volume of hydrochloric acid. Add a 10 per cent solution of potassium iodide five drops at a time till no further precipitation of black palladous iodide (PdI_2) takes place. Heat on the hot plate nearly to boiling. Cool, filter, and wash with dilute hydrochloric acid (1 acid : 4 water). Wash free from iron. Transfer

to a porcelain crucible and ignite in the muffle at a good red heat. Cool, moisten with a few drops of dilute formic acid to reduce oxide, and dry thoroughly on the hot plate. Transfer to the pan of the assay balance and weigh the palladium.

Textbooks usually describe palladous iodide as easily soluble in excess of KI. This is true, but the presence of a large amount of HCl probably prevents any excess of KI being present, hydriodic acid and potassium chloride being formed. This precipitation is complete. The strong hydrochloric-acid solution also prevents the precipitation of lead and copper iodides if only a slight excess of KI is used.

Dilute formic acid reduces palladium oxides to metal.

Determination of rhodium.—To the filtrate from PdI_2 and c.p. zinc till the solution is colorless, heating the solution while doing so. Allow all zinc to dissolve and the precipitate to settle. Decant the solution and wash the precipitate three times by decantation with 100 c. c. portions of hot water. Add 25 c. c. of dilute nitric acid (1 acid : 3 water) and place on top of the water bath for 10 minutes. Filter through an ashless filter, wash two or three times with water, ignite, reduce in hydrogen, and weigh as rhodium plus traces of iridium.

Zinc reduces all the platinum metals from solution. In this case only rhodium and traces of iridium are present. The nitric acid dissolves any base metals which may be present, but as freshly precipitated rhodium is slowly soluble in nitric acid, the treatment must not be too much prolonged.

A representative assay of crude metal would be the following: Osmiridium, 20 fine; Pt (containing 3 per cent Ir), 830; Pd, 5; Au, 30; Rh, 20 fine.

The strongly colored solutions furnished by all of the platinum metals, platinum giving the least color, is a good guide for washing, zinc precipitation, etc.

FIELD TESTS FOR PLATINUM.

The articles quoted are of greatest use to assayers, chemists, and those having access to well-equipped chemical laboratories. For the prospector and those with slight chemical equipment the identification of platinum and allied metals is not always certain. The following tests are believed to be most easily applied, and, if the material is carefully handled, they will give fairly reliable results.

Platinum as found in the placers of the Western States usually occurs as small scales or flakes, but in some placers it occurs as irregular nuggets. The distinctly metallic mineral has a color ranging from silvery white to steel-gray, its shade depending on the quantity of impurities present. In some placer deposits the grains of platinum are coated with a dark film and somewhat resemble grains of ilmenite or magnetite, from which, however, they are separated by careful washing, as platinum has a specific gravity equal to or greater than gold, and so stays in the pan with the gold.

Platinum will not amalgamate with quicksilver alone, but will amalgamate if sodium is added. In ordinary quicksilver amalgamation the flakes of platinum float on the surface and can be removed. If sodium is used, the platinum may be separated from gold by agitating the amalgam with water until all the sodium is used up to form sodium hydroxide, when the platinum will come out on the surface of the amalgam, provided, of course, that is sufficiently liquid.

Platinum has a hardness of 4 to 5, and can be scratched with a knife. It is so malleable that it can be pounded without heating into very thin sheets. It is infusible, can not be run together as gold can, and is insoluble in all acids except aqua regia, a mixture of two parts hydrochloric (muriatic) acid and one part nitric acid. This solution (platinum chloride?) is yellow, but its color is changed to deep red by the addition of metallic tin. From an aqua regia solu-

tion, potassium platinic chloride (K_2PtCl_6), a yellow crystalline precipitate is formed when potassium chloride (KCl) is added; or ammonium platinic chloride $(NH_4)_2PtCl_6$, also yellow, when ammonium chloride (NH_4Cl) is added. Both these precipitates are insoluble in alcohol but are soluble in water, and may be reduced by heating, so that sponge platinum is left.

Iridosmine flakes are distinguished from platinum by their brittleness and by their giving off a pungent, unpleasant odor if highly heated. This odor is caused by the decomposition of osmium. The flakes will scratch glass, but can be scratched by quartz.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA IN 1914.

(MINES REPORT.)

By Charles G. Yale.

PRODUCTION.

Number of mines producing in California, quantity of ore sold or treated, and total gold silver, copper, lead, and zinc produced in 1905–1914.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	1,139	2,696,603	$18,898,545	1,076,174	16,697,544	447,723	.....	$22,174,413
1906	1,017	2,556,056	18,732,452	1,220,641	28,726,448	338,718	206,000	25,126,359
1907	1,061	2,054,653	16,727,928	1,138,858	28,528,020	2,625,419	233,550	23,338,104
1908	1,054	2,546,908	18,761,559	1,647,278	38,776,881	1,237,548	.....	24,805,141
1909	1,127	3,041,688	20,237,870	2,098,253	57,288,281	1,502,597	.....	28,841,050
1910	1,079	2,697,885	19,715,440	1,840,085	48,700,756	2,870,977	.....	27,020,405
1911	1,181	2,797,261	19,738,908	1,270,445	36,316,136	1,398,111	2,807,035	25,174,677
1912	1,041	2,641,497	19,713,478	1,300,136	33,451,672	1,144,731	4,345,591	26,383,946
1913	796	2,495,958	20,406,958	1,378,399	34,575,007	3,514,342	1,057,485	26,812,487
1914	658	2,465,485	20,653,496	1,471,859	30,507,692	4,251,923	389,471	25,710,645
Increase (+) or decrease (−)	−138	−30,473	+246,538	+93,460	−4,067,315	+737,581	−668,014	−1,101,842

There was a decrease in California in 1914 in number of productive mines, in total quantity of ore treated, and in output of copper and zinc, but an increase in yield of gold, silver, and lead, the total value of the output for the year being $1,101,842 less than in 1913. The value of the gold increased $246,538; the silver increased by 93,460 ounces, and the lead by 737,581 pounds. The decline in copper was 4,067,315 pounds, and in zinc, 668,014 pounds.

In this table and in other tables in this chapter in which separate counties are considered, the values for gold and the quantities of silver bear no relation to the quantities of ore (although the other substances do), for the deep-mine gold and silver and the placer-mine gold and silver are combined under the respective headings of these metals in the general tables. Other tables are provided, however, to show the details. For example, in the table above the total output of gold for 1914 is shown as $20,653,496, of which $11,572,647 was derived from deep mines and $9,080,849 from placers. In the same way, of the total output of silver of 1,471,859 fine ounces, 1,436,982 fine ounces were from deep mines and 34,877 from the placers. Under head of producing mines both deep mines and placer mines are enumerated.

In 1914 there were 658 properties reporting production, of which 318 were deep mines and 340 were placers. The producing deep

mines of 1914 may be classified by metallic product as follows: Gold, 277; copper, 19; silver, 7; silver-lead, 6; and lead, 9. Of the placer mines, 105 were hydraulic, 3 less than in 1913; 60 were dredges, 3 less than in 1913; 70 were drift, 15 less than in 1913; and 105 were surface or sluicing mines, 25 less than in 1913. There were, all together, 46 fewer productive placer mines. Of deep mines there were 40 less gold, 32 less copper, 1 more silver, 19 less lead and lead-silver, and 2 less zinc mines—92 in all—in 1914 than in 1913. The dredges are enumerated by the number of boats at work, some companies owning only one, and others, several.

The 318 deep mines producing in 1914 made an output of 2,465,485 tons of ore, or 30,473 tons less than in 1913. Of this output 2,050,337 tons were siliceous ore, 397,868 tons copper ore, 640 tons lead ore, 460 tons silver ore, and 16,180 tons silver-lead ore. The siliceous ore increased by 18,908 tons, the copper ore decreased by 50,571 tons, the lead ore decreased by 13,627 tons, the silver ore increased by 460 tons, the silver-lead ore increased by 16,180 tons, and the zinc ore decreased by 1,823 tons.

The siliceous ore yielded an average per ton in gold and silver of $5.52; the copper ore, $1.84; the silver ore $81.86; the silver-lead ore, $17.03; and the lead ore, $15.88. The average per ton in gold and silver from all ores treated in the State in 1914 was $5.02.

The 2,465,485 tons of ore of all classes treated in California in 1914 yielded 559,826.80 fine ounces of gold, valued at $11,572,647; 1,436,-982 ounces of silver, valued at $794,651; 30,507,692 pounds of copper, valued at $4,057,523; 4,251,923 pounds of lead, valued at $165,825; and 389,471 pounds of zinc, valued at $19,863.

The value of all metals obtained from ore mined and treated in California in 1914 was $16,610,509, or an average of $6.74 a ton. In 1913 the output was valued at $17,954,941, or an average of $7.19 a ton. In 1912 the output was valued at $17,716,357, from 2,641,497 tons of ore of all classes, an average value of $6.71 a ton; in 1911 the output was 2,797,261 tons, valued at $16,167,193, an average value per ton of $5.49; in 1910 the output was 2,697,885 tons, valued at $18,109,008, an average value of $6.71 a ton; in 1909 it was 3,041,688 tons, valued at $19,715,314, an average of $6.48 a ton; and in 1908 it was 2,546,908 tons, valued at $16,536,226, an average value per ton of $6.49.

In 1914 there was treated at gold and silver mills 1,993,821 tons of ore, yielding altogether $10,743,207 in gold, an average value of $5.39 a ton, and 165,148 fine ounces of silver, valued at $91,327, an average value of 5 cents a ton, a total value of $10,834,534 in gold and silver, and an average value per ton of $5.44 in both metals. The average value per ton in 1913 was $5.57; in 1912 it was $5.08; in 1911, $4.64; in 1910, $5.25; in 1909, $4.88; and in 1908, $5.08.

There was recovered in 1914 as bullion in the mills $8,559,802 in gold, averaging $4.29 a ton, and 140,194 ounces of silver, valued at $77,527, averaging 4 cents a ton, a total of $8,637,329 in gold and silver, averaging $4.33 a ton in both metals.

From 1,993,821 tons of gold milling ore, 46,072 tons of concentrates were obtained, containing $2,183,405 in gold, an average of $47.39 a ton, and 24,954 ounces of silver, valued at $13,800, an average of 30 cents a ton. This was a yield in gold and silver valued at $2,197,205, or an average value recovered from the concentrates of $47.69 a ton.

Of the smelting ores there were 449,132 tons produced, with an output of gold of $748,073, an average of $1.67 a ton, and of 1,267,752 ounces of silver, valued at $701,067, an average recovery of $1.56. The total yield of gold and silver in the smelting ores was $1,449,140, or an average of $3.23 a ton.

There were treated also 22,532 tons of old tailings, yielding $81,367 in gold, an average of $3.61 a ton, and 4,082 ounces of silver, valued at $2,257, an average of 10 cents a ton. The total gold and silver produced from the tailings was valued at $83,624, an average of $3.71 a ton.

The 340 productive placer mines in California in 1914 yielded 439,286.07 fine ounces of gold, valued at $9,080,849, and 34,877 ounces of silver, valued at $19,287, a total value in gold and silver of $9,100,136. This was an increase of $242,590 over the output of 1913. The increase of gold was $244,672, but the silver decreased by $2,082. In production of gold the dredge properties showed a decrease of $306,900 in 1914, and the hydraulic mines showed an increase of $373,584. In the same period the drift mines showed an increase of $137,410, and the surface placer or sluicing mines an increase of $40,578. The increase in gold output from the hydraulic, drift, and surface placers was thus $551,572, or $244,672 more than the decrease in the yield from dredges.

The following table shows the production of gold, silver, copper, lead, and zinc in California in 1914, by counties:

Mine production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California in 1914.

County.	Ore treated.	Deep-mine gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ozs.*		*Fine ozs.*		*Fine ozs.*	
Amador	630,993	148,653.04	$3,072,931	438.81	$9,071	149,091.85	$3,082,002
Butte	409	201.29	4,161	81,896.89	1,692,959	82,098.18	1,697,120
Calaveras	407,746	43,807.09	905,573	20,864.23	431,302	64,671.32	1,336,875
Del Norte				98.44	2,035	98.44	2,035
El Dorado	18,488	4,403.29	91,024	2,073.45	42,862	6,476.74	133,886
Fresno	642	494.92	10,231			494.92	10,231
Humboldt				903.94	18,686	903.94	18,686
Imperial	41,763	10,179.45	210,428			10,179.45	210,428
Inyo	41,189	12,854.88	265,734			12,854.88	265,734
Kern	177,234	28,591.41	591,037	159.64	3,300	28,751.05	594,337
Lassen	600	60.47	1,250			60.47	1,250
Madera	316	188.13	3,889	29.85	617	217.98	4,506
Mariposa	14,719	6,279.85	129,816	79.43	1,642	6,359.28	131,458
Modoc	16	25.49	527			25.49	527
Mono	400	329.97	6,821			329.97	6,821
Monterey	117	214.01	4,424			214.01	4,424
Nevada	278,272	147,928.53	3,057,954	11,803.21	243,994	159,731.74	3,301,948
Placer	36,851	6,521.53	134,812	22,368.60	462,400	28,890.13	597,212
Plumas	20,036	3,077.13	63,610	3,513.33	72,627	6,590.46	136,237
Riverside	1,111	543.25	11,230			543.25	11,230
Sacramento				104,707.25	2,164,491	104,707.25	2,164,491
San Bernardino	32,037	10,098.38	208,752	34.83	720	10,133.21	209,472
Shasta	436,211	47,056.88	972,752	6,213.77	128,450	53,270.65	1,101,202
Sierra	65,411	29,201.33	603,645	5,733.31	118,518	34,934.64	722,163
Siskiyou	10,543	2,193.23	45,338	12,940.50	267,504	15,133.73	312,842
Trinity	27,720	11,322.56	234,058	24,644.84	509,454	35,967.40	743,512
Tuolumne	222,507	45,510.86	940,793			45,510.86	940,793
Yuba	154	89.83	1,857	135,394.66	2,798,856	135,484.49	2,800,713
Merced and Stanislaus[a]				5,387.09	111,361	5,387.09	111,361
Total	2,465,485	559,826.80	11,572,647	439,286.07	9,080,849	999,112.87	20,653,496
Total, 1913	2,495,958	559,736.53	11,570,781	427,450.06	8,836,177	987,186.59	20,406,958
Increase(+) or decrease(−)	−30,473	+90.27	+1,866	+11,836.01	+244,672	+11,926.28	+246,538

[a] Dredge production combined to conceal output.

Mine production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California in 1914—Continued.

County.	Deep-mine silver.		Placer silver.		Total silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Fine ozs.*		*Pounds.*	
Amador	30,740	$16,999	60	$33	30,800	$17,032	5,218	$694
Butte	22	12	6,367	3,521	6,389	3,533	.....	.....
Calaveras	107,505	59,450	1,794	992	109,299	60,442	4,395,444	584,594
Del Norte	.....	.....	16	9	16	9	.....	.....
El Dorado	928	513	255	141	1,183	654	.....	.....
Fresno	56	31	.....	.....	56	31	.....	.....
Humboldt	.....	.....	103	57	103	57	.....	.....
Imperial	16,204	8,961	.....	.....	16,204	8,961	11,414	1,518
Inyo	466,575	258,016	.....	.....	466,575	258,016	292,812	38,944
Kern	14,450	7,991	20	11	14,470	8,002	.....	.....
Lassen	7	4	.....	.....	7	4	.....	.....
Madera	62	34	4	2	66	36	.....	.....
Mariposa	1,213	671	11	6	1,224	677	170,241	22,642
Modoc	9	5	.....	.....	9	5	.....	.....
Mono	16,436	9,089	.....	.....	16,436	9,089	3,812	507
Monterey	34	19	.....	.....	34	19	.....	.....
Nevada	47,429	26,228	1,058	585	48,487	26,813	.....	.....
Placer	5,828	3,223	2,568	1,420	8,396	4,643	496	66
Plumas	5,365	2,967	353	195	5,718	3,162	339,744	45,186
Riverside	161	89	.....	.....	161	89	22	3
Sacramento	.....	.....	6,295	3,481	6,295	3,481	.....	.....
San Bernardino	67,732	37,456	5	3	67,737	37,459	89,820	11,946
Shasta	625,947	346,149	1,007	557	626,954	346,706	25,198,669	3,351,423
Sierra	4,732	2,617	631	349	5,363	2,966	.....	.....
Siskiyou	322	178	1,533	848	1,855	1,026	.....	.....
Trinity	3,472	1,920	2,629	1,454	6,101	3,374	.....	.....
Tuolumne	21,731	12,017	.....	.....	21,731	12,017	.....	.....
Yuba	22	12	9,553	5,283	9,575	5,295	.....	.....
Merced and Stanislaus[a]	.....	.....	615	340	615	340	.....	.....
Total	1,436,982	794,651	34,877	19,287	1,471,859	813,938	30,507,602	4,057,523
Total, 1913	1,343,020	811,184	35,379	21,369	1,378,399	832,553	34,575,007	5,359,126
Increase (+) or decrease (−)	+93,962	−16,533	−502	−2,082	+93,460	−18,615	−4,067,315	−1,301,603

County.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Amador	.....	.....	.....	.....	$3,099,723
Butte	.....	.....	.....	.....	1,700,653
Calaveras	.....	.....	.....	.....	1,981,911
Del Norte	.....	.....	.....	.....	2,044
El Dorado	.....	.....	.....	.....	134,540
Fresno	.....	.....	.....	.....	10,262
Humboldt	.....	.....	.....	.....	18,743
Imperial	.....	.....	.....	.....	220,907
Inyo	4,205,154	$164,001	389,471	$19,863	746,558
Kern	6,641	259	.....	.....	602,598
Lassen	.....	.....	.....	.....	1,254
Madera	.....	.....	.....	.....	4,542
Mariposa	.....	.....	.....	.....	154,777
Modoc	.....	.....	.....	.....	532
Mono	.....	.....	.....	.....	16,417
Monterey	.....	.....	.....	.....	4,443
Nevada	.....	.....	.....	.....	3,328,761
Placer	615	24	.....	.....	601,945
Plumas	.....	.....	.....	.....	184,585
Riverside	.....	.....	.....	.....	11,322
Sacramento	.....	.....	.....	.....	2,167,972
San Bernardino	39,513	1,541	.....	.....	260,418
Shasta	.....	.....	.....	.....	4,799,331
Sierra	.....	.....	.....	.....	725,129
Siskiyou	.....	.....	.....	.....	313,868
Trinity	.....	.....	.....	.....	746,886
Tuolumne	.....	.....	.....	.....	952,810
Yuba	.....	.....	.....	.....	2,806,008
Merced and Stanislaus[a]	.....	.....	.....	.....	111,701
Total	4,251,923	165,825	389,471	19,863	25,710,645
Total, 1913	3,514,342	154,631	1,057,485	59,219	26,812,487
Increase (+) or decrease (−)	+737,581	+11,194	−668,014	−39,356	−1,101,842

[a] Dredge production combined to conceal output.

GOLD.

The total production of gold in California in 1914 was 999,112.87 fine ounces, valued at $20,653,496, as compared with 987,186.59 fine ounces, valued at $20,406,958 in 1913, an increase of 11,926.28 fine ounces, valued at $246,538, or 1.21 per cent for 1914. The deep mines of the State yielded 559,826.80 fine ounces of gold, valued at $11,572,647. Of the deep-mine gold, 541,743.93 fine ounces, valued at $11,198,841, was derived from siliceous ore; 16,630.16 fine ounces, valued at $343,776, was derived from copper ore; 35.37 fine ounces, valued at $731, from lead ore; 71.69 fine ounces, valued at $1,482, from silver ore; and 1,345.65 fine ounces, valued at $27,817, from silver-lead ores.

The placer yield of gold in 1914 was 439,286.07 fine ounces, valued at $9,080,849. Of this $702,884 was derived from 105 hydraulic mines; $7,783,394 from 60 dredges; $329,948 from 70 drift mines; and $264,623 from 105 surface or sluicing mines. The placers produced 43.97 per cent of the total gold yield for 1914, and the deep mines 56.03, as compared with 43.30 per cent for the placers and 56.70 for the deep mines in 1913.

The dredges in the State produced 37.69 per cent of the total gold yield from all sources in 1914. Of the total placer gold the dredges produced 85.71 per cent; the hydraulic mines, 7.74 per cent; the drift mines, 3.63 per cent; and the surface or sluicing mines, 2.92 per cent. The dredge mining record for the last 17 years is shown in the following table, with the increase or decrease for each year:

Value of gold won by dredging in California, 1898–1914, with increase (+) or decrease (−), by years.

Year.	Number of dredges.	Value.	Increase (+) or decrease (−).
1898	3	$18,887	
1899	8	206,302	+ $187,415
1900	16	200,929	− 5,373
1901	22	471,762	+ 270,833
1902	29	867,665	+ 395,903
1903	31	1,475,749	+ 608,084
1904	42	2,187,038	+ 711,289
1905	50	3,276,141	+1,089,103
1906	59	5,098,359	+1,822,218
1907	57	5,065,437	− 32,922
1908	69	6,536,189	+1,470,752
1909	63	7,382,950	+ 846,761
1910	72	7,550,254	+ 167,304
1911	65	7,666,461	+ 116,207
1912	65	7,429,955	− 236,506
1913	63	8,090,294	+ 660,339
1914	60	7,783,394	− 306,900
Total		71,307,766	

The three important dredging fields of the State are the Oroville, Butte County; Folsom, Sacramento County; and Marysville, Yuba County. Dredges are also operated in seven other counties—4 in Calaveras, 1 in Merced, 3 in Placer, 3 in Shasta, 2 in Siskiyou, 1 in Stanislaus, and 2 in Trinity. The Yuba County dredges, 12 in operation, made the largest output of gold in 1914, the value being $2,755,734, an increase of $335,279. Sacramento County, with 11 dredges at work, made an output of gold of $2,161,653, a decrease of

$336,950. Butte County (including Oroville and "outside" districts), where 21 dredges were in operation, decreased in yield by $485,411. This statement shows that there was $487,082 less gold obtained by dredging in these three fields in 1914 than in 1913. The total gold deficit in dredging in 1914, as compared with 1913, was $306,900. This was mainly due to the fact that certain companies have worked out their available ground and have ceased operations in consequence.

Of the 30 counties producing gold in 1914 in California, 9 yielded no placer gold and 5 no gold from deep mines. Seven counties yielded more than $1,000,000 each in gold in 1914, as follows: Nevada, $3,301,948; Amador, $3,082,002; Yuba, $2,800,713; Sacramento, $2,164,491; Butte, $1,697,120; Calaveras, $1,336,875; and Shasta, $1,101,202. Two of these counties, it may be noted, produced each more than $3,000,000 and two more than $2,000,000.

The largest production of gold in California in 1914 came, as in 1913, from Nevada County. The leading hydraulic mining county was Trinity; the greatest producer of gold from drift mines was Placer; the largest producer of gold from dredges was Yuba; and the largest producer of gold from surface or sluicing mines was Nevada. The largest increase in total yield of gold in 1914, as compared with 1913, was in Nevada County, an increase of $383,215, which was followed by Placer, with $376,427; Trinity, with $311,650; Yuba, with $309,208; Amador, with $180,104; Imperial, with $178,728; Calaveras, with $161,667; Siskiyou, with $80,870; El Dorado, with $71,198; Inyo, with $28,424; Fresno, with $7,385; and Lassen, with $1,250. Some counties showed a decreased yield of gold for the year, as Butte, $572,729; Sacramento, $339,142; Sierra, $284,410; San Bernardino, $147,052; Mono, $140,450; Shasta, $107,668; Stanislaus, $76,304; Kern, $55,375; Mariposa, $39,576; Tuolumne, $33,616; Merced, $15,909; Madera, $9,983; Humboldt, $6,925; Modoc, $5,534; Los Angeles, $2,322; Plumas, $2,131; Monterey, $2,067; Riverside, $1,271; Alpine, $537; Del Norte, $463; and San Luis Obispo, $124.

The production of gold from placers and from different kinds of ore in California in 1914, by counties, in fine ounces, is given in the following table:

Source of mine production of gold in California by kinds of ore in 1914, by counties, in fine ounces.

County.	Placers.	Deep mines.						Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Silver ores.	Silver-lead ores.	Total.	
Amador	438.81	148,632.29	20.75				148,653.04	149,091.85
Butte	81,896.89	201.29					201.29	82,098.18
Calaveras	20,864.23	40,590.49	3,216.60				43,807.09	64,671.32
Del Norte	98.44							98.44
El Dorado	2,073.45	4,403.29					4,403.29	6,476.74
Fresno		494.92					494.92	494.92
Humboldt	903.94							903.94
Imperial		10,179.45					10,179.45	10,179.45
Inyo		11,464.62	.44	26.37	18.82	1,344.63	12,854.88	12,854.88
Kern	159.64	28,591.41					28,591.41	28,751.05
Lassen		60.47					60.47	60.47
Madera	29.85	188.13					188.13	217.98
Mariposa	79.43	6,267.66	12.19				6,279.85	6,359.28
Modoc		25.49					25.49	25.49
Mono		291.27			38.70		329.97	329.97
Monterey		214.01					214.01	214.01

Source of mine production of gold in California by kinds of ore in 1914, by counties, in fine ounces—Continued.

County.	Placers.	Deep mines.						Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Silver ores.	Silver-lead ores.	Total.	
Nevada	11,803.21	147,928.53					147,928.53	159,731.74
Placer	22,368.60	6,513.55	7.98				6,521.53	28,890.13
Plumas	3,513.33	3,049.56	27.57				3,077.13	6,590.46
Riverside		543.25					543.25	543.25
Sacramento	104,707.25							104,707.25
San Bernardino	34.83	9,847.80	226.39	9.00	14.17	1.02	10,098.38	10,133.21
Shasta	6,213.77	33,938.64	13,118.24				47,056.88	53,270.65
Sierra	5,733.31	29,201.33					29,201.33	34,934.64
Siskiyou	12,940.50	2,193.23					2,193.23	15,133.73
Trinity	24,644.84	11,322.56					11,322.56	35,967.40
Tuolumne		45,510.86					45,510.86	45,510.86
Yuba	135,394.66	89.83					89.83	135,484.49
Merced and Stanislaus [a]	5,387.09							5,387.09
Total	439,286.07	541,743.93	16,630.16	35.37	71.69	1,345.65	559,826.80	999,112.87
Total, 1913	427,450.06	542,891.65	15,525.41	1,319.47			559,736.53	987,186.59
Increase (+) or decrease (−)	+11,836.01	−1,147.72	+1,104.75	−1,284.10	+71.69	+1,345.65	+90.27	+11,926.28

[a] Dredge production combined to conceal output.

From the siliceous ore and from old tailings the recovery of gold by processes in California in 1914 was as follows: By amalgamation 353,386.29 fine ounces, valued at $7,305,143; by cyanidation, 64,630.26 fine ounces, valued at $1,336,026; and by chlorination, 15,819.54 fine ounces, valued at $327,019. There were but two chlorination plants in operation in the State in 1914. There were 21 separate plants where the cyanide process was used in 1914. Gold valued at $748,073 was obtained from smelting crude ores, and $1,856,386 in gold was obtained from concentrates treated at custom reduction plants and smelters.

The source of placer gold, by counties and from various kinds of mines, is shown as follows:

Value and source of placer gold in California in 1914, by counties.

County.	Hydraulic.	Dredging.	Drift.	Surface placers.	Total.
Amador			$6,376	$2,695	$9,071
Butte	$5,034	$1,637,515	43,732	6,678	1,692,959
Calaveras	3,746	390,390	31,929	5,237	431,302
Del Norte	1,228			807	2,035
El Dorado	3,327		5,867	33,668	42,862
Humboldt	18,479			207	18,686
Kern	3,300				3,300
Madera				617	617
Mariposa				1,642	1,642
Merced and Stanislaus [a]		111,361			111,361
Nevada	87,078		44,326	112,590	243,994
Placer	12,004	296,012	132,709	21,675	462,400
Plumas	32,077		12,956	27,594	72,627
Sacramento		2,161,653	2,838		2,164,491
San Bernardino				720	720
Shasta		113,283		15,167	128,450
Sierra	83,217		31,931	3,370	118,518
Siskiyou	152,185	113,464	165	1,690	267,504
Trinity	301,209	203,982	150	4,113	509,454
Yuba		2,755,734	16,969	26,153	2,798,856
Total	702,884	7,783,394	329,948	264,623	9,080,849

[a] Dredge production combined to conceal separate output.

The increase or decrease of the production of gold, by counties, in 1914 as compared with 1913, is shown in the following table:

Increase and decrease in mine production of gold in California in 1914, by counties.

County.	Increase.	Decrease.
Alpine		$537
Amador	$180,104	
Butte		572,729
Calaveras	161,667	
Del Norte		463
El Dorado	71,198	
Fresno	7,385	
Humboldt		6,925
Imperial	178,728	
Inyo	28,424	
Kern		55,375
Lassen	1,250	
Los Angeles		2,322
Madera		9,983
Mariposa		39,576
Merced		15,909
Modoc		5,534
Mono		140,450
Monterey		2,067
Nevada	383,215	
Placer	376,427	
Plumas		2,131
Riverside		1,271
Sacramento		339,142
San Bernardino		147,052
San Luis Obispo		124
Shasta		107,668
Sierra		284,410
Siskiyou	80,870	
Stanislaus		76,304
Trinity	311,650	
Tuolumne		33,616
Yuba	309,208	
Total	2,090,126	1,843,,588
Total increase	246,538	

SILVER.

The yield of silver in California in 1914 was 1,471,859 fine ounces, valued at $813,938, an increase in quantity of 93,460 ounces, but a decrease in value of $18,615. The larger portion of the output, or 1,267,752 ounces, valued at $701,067, was derived from crude smelting ores. The output of siliceous ore, both milled and smelted, yielded 203,413 fine ounces, valued at $112,487. The largest output of silver came, as usual, from Shasta County, which produced from copper ores, 592,727 ounces, valued at $327,778; from siliceous ore, 33,220 ounces, valued at $18,371, and from placers 1,007 fine ounces, valued at $557—a total yield from the county in silver of 626,954 ounces, valued at $346,706; in 1913 the county produced 741,773 fine ounces of silver, valued at $448,031—a decrease in 1914, as compared with 1913, of 114,819 ounces in quantity and of $101,325 in value. Inyo County followed Shasta quite closely in yield of silver in 1914, the output being 466,575 ounces, valued at $258,016—an increase for the county in 1914, as compared with 1913, of 239,996 ounces in quantity and of $121,162 in value. This was almost entirely from silver-lead ores. The total silver derived from deep mines of all classes in California in 1914 was 1,436,982 ounces, valued at $794,651. The silver obtained with gold in placer mining in the

State in 1914 was 34,877 ounces, valued at $19,287. The largest producer of placer silver was Yuba County, with 9,553 ounces, valued at $5,283.

The following table shows the source of the mine output of silver in California in 1914, by placers and kinds of ore, in fine ounces:

Source of mine production of silver in California by kinds of ore in 1914, in fine ounces.

County.	Placers.	Deep mines.						Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Silver ores.	Silver-lead ores.	Total.	
Amador	60	30,049	691	.....	.....	.....	30,740	30,800
Butte	6,367	22	.....	.....	.....	.....	22	6,389
Calaveras	1,794	5,107	102,398	.....	.....	.....	107,505	109,299
Del Norte	16	.....	.....	.....	.....	.....	.....	16
El Dorado	255	928	.....	.....	.....	.....	928	1,183
Fresno	.....	56	.....	.....	.....	.....	56	56
Humboldt	103	.....	.....	.....	.....	.....	.....	103
Imperial	.....	16,204	.....	.....	.....	.....	16,204	16,204
Inyo	.....	6,429	1,224	16,237	4,117	438,568	466,575	466,575
Kern	20	14,450	.....	.....	.....	.....	14,450	14,470
Lassen	.....	7	.....	.....	.....	.....	7	7
Madera	4	62	.....	.....	.....	.....	62	66
Mariposa	11	949	264	.....	.....	.....	1,213	1,224
Modoc	.....	9	.....	.....	.....	.....	9	9
Mono	.....	42	.....	.....	16,394	.....	16,436	16,436
Monterey	.....	34	.....	.....	.....	.....	34	34
Nevada	1,058	47,429	.....	.....	.....	.....	47,429	48,487
Placer	2,568	5,770	58	.....	.....	.....	5,828	8,396
Plumas	353	365	5,000	.....	.....	.....	5,365	5,718
Riverside	.....	161	.....	.....	.....	.....	161	161
Sacramento	6,295	.....	.....	.....	.....	.....	.....	6,295
San Bernardino	5	11,841	680	821	44,904	9,486	67,732	67,737
Shasta	1,007	33,220	592,727	.....	.....	.....	625,947	626,954
Sierra	631	3,732	.....	.....	.....	.....	4,732	5,363
Siskiyou	1,533	322	.....	.....	.....	.....	322	1,855
Trinity	2,629	3,472	.....	.....	.....	.....	3,472	6,101
Tuolumne	.....	21,731	.....	.....	.....	.....	21,731	21,731
Yuba	9,553	22	.....	.....	.....	.....	22	9,575
Merced and Stanislaus[a]	615	.....	.....	.....	.....	.....	.....	615
Total	34,877	203,413	703,042	17,058	65,415	448,054	1,436,982	1,471,859
Total, 1913	35,379	289,119	833,672	220,229	.....	.....	1,343,020	1,378,399
Increase (+) or decrease—	−502	− 85,706	−130,630	−203,171	+65,415	+448,054	+ 93,962	+93,460

[a] Dredge production combined to conceal output.

From the siliceous ore and old tailings treated in California in 1914 the recovery of silver by amalgamation was 84,421 fine ounces, valued at $46,685; by cyanidation, 59,855 fine ounces, valued at $33,100; by chlorination, 2,510 ounces, valued at $1,388; and from smelting ore, 1,267,752 fine ounces, valued at $701,067, a total from these sources of 1,414,538 fine ounces, valued at $782,240. As the production of silver from deep mines was 1,436,982 fine ounces, valued at $794,651, the production from concentrates treated at custom mills and smelters was 22,444 fine ounces, valued at $12,411.

COPPER.

The mine production of copper in California in 1914 was 30,507,692 pounds, valued at $4,057,523, a decrease of 4,067,315 pounds in quantity and of $1,301,603 in value. Copper was produced in Amador, Calaveras, Imperial, Inyo, Mariposa, Mono, Placer, Plumas, Riverside, San Bernardino, and Shasta counties. The heaviest produc-

tion, as usual, came from Shasta County, but in that county there was a decrease in quantity of 1,845,628 pounds and in value of $840,443 in 1914, as compared with 1913. Altogether there were 397,868 tons of copper ore treated, or 50,571 tons less than in 1913. The smelter-fume litigation still keeps several of the large smelting plants idle, only one of the Shasta County smelters, the Mammoth, having been operated. The ores of the Mountain Copper Co., of the same county, were treated at the smelter of the company near Martinez, which was, however, closed for part of the year owing to conditions brought about by the European war. The Penn Mining Co., of Calaveras County, operated its blast and reverberatory furnaces on its own ore. The copper ores in California in 1914 yielded, in addition to the copper, 16,630.16 fine ounces of gold, valued at $343,776, and 703,042 ounces of silver, valued at $388,782.

LEAD.

The mine production of lead in California in 1914 was 4,251,923 pounds, valued at $165,825, as compared with 3,514,342 pounds, valued at $154,631 in 1913, an increase in quantity in 1914 of 737,581 pounds and in value of $11,194. From the lead ore was obtained also 35.37 fine ounces of gold, valued at $731, and 17,058 ounces of silver, valued at $9,433. The total value of the output from the lead-mining industry of the State in 1914, in lead and contained value of gold and silver, was $175,989. This refers to ores classified as lead ores only, and does not consider the gold and silver obtained from those ores classified as silver-lead. Most of the lead was derived from Inyo County, although there was a considerable quantity from Shasta County, and a nominal product from both Kern and Placer counties.

ZINC.

The recoverable mine production of zinc in California in 1914 was 389,471 pounds, valued at $19,863, as compared with 1,057,485 pounds, valued at $59,219, in 1913, a decrease for 1914 of 668,014 pounds in quantity and of $39,356 in value. There were only three mines in the State producing zinc, all in Inyo County.

MINING AND METALLURGICAL INDUSTRIES IN CALIFORNIA IN 1914.

The total value of the gold, silver, copper, lead, and zinc produced in California in 1914 shows a decrease of $1,101,842, or 4 per cent. The greatest relative decrease was in copper, and was 4,067,315 pounds in quantity and $1,301,603 in value. This decrease was entirely due to the closing for five months of the year of the smelting plant of the second largest producer of copper in the State by reason of conditions brought about by the European war, the company being an English one. The gold increase was $246,538, or 1.2 per cent, the output having been $20,653,496, as compared with $20,406,958 in 1913. The deep mines of the State produced $11,572,647, or 56 per cent of the total yield of gold in 1914. The increase of gold from the deep mines in 1914 was merely nominal—$1,866. The placer mines produced $9,080,849, or 44 per cent of the total. The increase in placer gold was $244,672, or 2.7 per cent.

The silver output increased in quantity by 93,460 fine ounces, but decreased in value by $18,615. Of this decrease the deep mines are responsible for $16,533, and the placer mines for $2,082.

The output of $20,653,496 in gold in California was the largest in 32 years, the output in 1883 having been $24,316,873. In fact, it is only the fourth time in 50 years that the output has exceeded $20,000,000. In 1864 the gold was valued at $24,071,423; in 1880 it was valued at $20,030,761, and it exceeded that value again in 1883. So that, with the exception of the single year 1883, the output of gold in the State was higher in 1914 than it has been since 1864. This record was made notwithstanding that the number of producing mines in the State fell off 21 per cent in 1914 as compared with 1913. It is the operations carried on upon an extensive scale that are now producing the increased quantity of gold rather than the efforts of individuals or the numerous small enterprises. This is particularly the case in connection with gold-dredging operations, a comparatively modern feature in gold mining, without which the placer-gold yield of the State would be of small consequence. Since the commencement of dredging operations in the State 17 years ago, the gold output from that source has been $71,307,766; and from an output of $18,887 in 1898 the annual dredge yield increased to $8,090,294 in 1913, and was $7,783,394 in 1914.

Since 1902 the Oroville (Butte County) field has yielded $26,630,358 in gold—previous years not included nor $1,412,869 derived in the last five years from dredges in adjacent districts of the same county. The Marysville (Yuba County) field increased from a yield of dredge gold of $25,736 in 1902 to $2,755,734 in 1914, and had a total placer production of gold from 1903 to 1914, inclusive, of $21,667,739. The Folsom (Sacramento County) dredging field increased from a yield of $155,194 in 1902 to $2,161,653 in 1914, or a total from 1902 to 1914 of $14,900,104. These figures do not relate to the numerous other dredges operating in other localities in the State.

In view of the preceding brief discussion of the output of the principal placer fields of the State, it will be of interest to note generally the output of ore, the yield in metal, and the average value per ton of the principal deep-mine centers. In the Mother Lode region, Jackson and Sutter Creek, in Amador County, may be considered as one district, just as Grass Valley and Nevada City, in Nevada County, may be considered as one district. In Jackson district are located the largest producers on the Mother Lode. At these combined mines in 1914 there were 387,602 tons of ore treated, which yielded $2,113,098 in gold, or $5.45 a ton; and $12,674 in silver, or $0.03 per ton—a total of $2,125,772 in gold and silver, or $5.48 a ton. In the Grass Valley district there were 267,618 tons of ore treated, which yielded $2,997,405 in gold, or $11.20 a ton; and $25,868 in silver, or $0.10 a ton—a total in gold and silver of $3,023,273, or $11.30 a ton. At Kennett, Shasta County, where the Mammoth Copper Co.'s mines and smelter are located, 243,138 tons of ore were treated from all the mines, which yielded $376,846 in gold, or $1.55 a ton; $299,110 in silver, or $1.23 a ton; and $2,411,323 in copper, or $9.92 a ton—making a total of $3,087,279, or $12.70 a ton.

In 1914 there were 7 silver mines operated in California and 6 silver-lead mines. These two classes of ore have not heretofore been

represented in the California table. Silver produced from silver mines amounted to 65,415 ounces, valued at $36,175, as well as $1,482 in gold. The silver-lead mines produced 448,054 ounces of silver, valued at $247,774, as well as $27,817 in gold, and 3,831,394 pounds of lead, valued at $149,424.

The average value per ton in all metals of the different classes of ore mines and treated in California in 1914 was as follows: Siliceous ore, $5.53 a ton; copper ores, $11.90 a ton; lead ores, $43.94; silver ores, $83.90; and silver-lead ores, $29.75. Of the 2,465,485 tons of ore treated, 2,050,337 were siliceous.

In the section on production by counties in this report the details of mining work in the Mother Lode counties are given. A condensed statement of the record of these Mother Lode counties, including all deep mines in those counties, is given in the following table:

Quantity of ore and value recovered in bullion in gold and silver mills, quantity and value of concentrates produced, and total recovery, with average value per ton, in Mother Lode counties in California, 1914.

County.	Ore to gold and silver mills.				Concentrates produced.				Value of total recovery.	Value of total average recovery per ton.
	Quantity.	Gold in bullion.	Silver in bullion.	Average value in gold and silver recovered on plates per ton.	Quantity.	Gold.	Silver.	Average value in gold and silver per ton.		
	Short tons.		*Fine ounces.*		*Short tons.*		*Fine ounces.*			
Amador	629,037	$1,995,787	20,740	$3.19	14,091	$1,065,581	9,228	$75.98	$3,077,940	$4.90
Calaveras	359,509	467,145	2,977	1.30	15,212	364,022	1,535	23.99	833,662	2.32
El Dorado	18,488	62,683	384	3.40	365	28,341	544	78.47	91,537	4.95
Mariposa	13,990	113,878	891	8.18	261	14,177	47	54.42	128,574	9.19
Tuolumne	222,505	595,623	17,454	2.72	9,418	337,561	1,814	35.95	943,839	4.24
Total	1,243,529	3,235,116	42,446	2.62	39,347	1,809,682	13,168	44.18	5,075,552	4.08

A comparison of this table with the corresponding table for 1913 shows a total increase in ore treated for the five Mother Lode counties in 1914 of 1,186 tons. An increase was shown in Amador, Calaveras, and El Dorado counties and a decrease in Mariposa and Tuolumne counties.

In the Mother Lode counties in 1914 there were treated in gold and silver mills 1,243,529 tons of ore, yielding $5,075,552 in gold and silver, an average of $4.08 a ton, as compared with 1,242,343 tons treated in 1913, yielding $4,728,450 in gold and silver, or an average of $3.81 a ton; 1,299,988 tons treated in 1912, which yielded $4,803,935 in gold and silver, or $3,69 a ton, and 1,377,084 tons in 1911, which yielded $4,910,358 in gold and silver, or an average of $3.57 a ton. From these figures it will be noted that between 1911 and 1913, inclusive, there was a gradual reduction in quantity of ore from these counties as well as a gradual decrease in total value. At the same time there was an increase each year in the average value of recovery per ton. In 1914, however, there was a small increase in ore, as compared with 1913, and an increase in total value of $347,102, and for the first time in some years a record of $4.08 in value and average recovery by ton. This average recovery was 27 cents a ton higher

than in 1913. The average value of gold and silver recovered in the mills as bullion in 1914 was 11 cents a ton more than in 1913, and in 1913 it was 11 cents more than in 1912. The average value of gold and silver in the concentrates per ton in 1914 was $46.18, as compared with $56.77 in 1913. There were 39,347 tons of concentrates obtained from the 1,243,529 tons of ore worked in these counties in 1914.

The total quantity of ore treated at gold and silver mills from the deep mines of the State in 1914 was 1,993,821 tons, or 88,563 tons more than in 1913. Of the total ore milled 1,243,529 tons (62.4 per cent), came from the Mother Lode counties in 1914. Amador, the largest producer of the Mother Lode counties, produced 629,037 tons of milling ore, or more than 31 per cent of the total production of ore milled in the State in 1914 and 50.6 per cent of the ore milled in the Mother Lode counties.

The total quantity, by kinds, or ore sold or treated in each county of California in 1914, is shown in the following table:

Subdivision of quantity of crude ore sold or treated in California in 1914, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Silver ore.	Silver-lead ore.	Total ore.
Amador	630,918	75	.....	.....	.....	630,993
Butte	409	.....	.....	.....	.....	409
Calaveras	364,011	43,735	.....	.....	.....	407,746
El Dorado	18,488	.....	.....	.....	.....	18,488
Fresno	642	.....	.....	.....	.....	642
Imperial	41,763	.....	.....	.....	.....	41,763
Inyo	24,375	22	587	92	16,113	41,189
Kern	177,234	.....	.....	.....	.....	177,234
Lassen	600	.....	.....	.....	.....	600
Madera	316	.....	.....	.....	.....	316
Mariposa	14,111	608	.....	.....	.....	14,719
Modoc	16	.....	.....	.....	.....	16
Mono	338	.....	.....	62	.....	400
Monterey	117	.....	.....	.....	.....	117
Nevada	278,272	.....	.....	.....	.....	278,272
Placer	36,845	6	.....	.....	.....	36,851
Plumas	18,838	1,198	.....	.....	.....	20,036
Riverside	1,111	.....	.....	.....	.....	1,111
San Bernardino	31,378	233	53	306	67	32,037
Shasta	84,220	351,991	.....	.....	.....	436,211
Sierra	65,411	.....	.....	.....	.....	65,411
Siskiyou	10,543	.....	.....	.....	.....	10,543
Trinity	27,720	.....	.....	.....	.....	27,720
Tuolumne	222,507	.....	.....	.....	.....	222,507
Yuba	154	.....	.....	.....	.....	154
Total	2,050,337	397,868	640	460	16,180	2,465,485
Increase (+) or decrease (−)	+18,908	−50,571	−13,627	+460	+16,180	−30,473
Average value per ton in gold and silver	$5.52	$1.84	$15.88	$81.86	$17.03	$5.02

Zinc ores in 1913 amounted to 1,823 short tons.

Total yield and average value per ton in gold and silver and in all metals, of the different classes of ore mined and treated in California in 1914.

Class of ore.	Ore.	Total value of gold and silver.	Total value in all metals.	Average value per ton of gold and silver.	Average value per ton in all metals.
	Short tons.				
Siliceous	2,050,337	$11,311,328	$11,327,943	$5.52	$5.52
Copper	397,868	732,558	4,734,539	1.84	11.90
Lead	640	10,164	28,119	15.88	43.94
Silver-lead	16,180	275,591	481,316	17.03	29.75
Silver	460	37,657	38,592	81.86	83.90
Total	2,465,485	12,367,298	16,610,509	5.02	6.74

The subdivision of ore and production of gold and silver in California in 1914, according to methods of treatment, is shown in the following table:

Subdivision of ore and production of gold and silver in California in 1914, according to methods of treatment, by counties.

County.	Ore to gold and silver mills.			Concentrates produced.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ozs.*	*Short tons.*		*Fine ozs.*
Amador	629,037	$1,995,787	20,740	14,091	$1,065,581	9,228
Butte	409	4,161	22	.....	.....	.....
Calaveras	359,509	467,145	2,977	15,212	364,022	1,535
El Dorado	18,488	62,683	384	365	28,341	544
Fresno	642	10,231	56	.....	.....	.....
Imperial	41,717	154,731	15,409	785	50,695	721
Inyo	[a] 23,649	236,679	6,414	1	129	2
Kern	174,815	577,913	10,853	71	2,642	917
Lassen	600	1,250	7	.....	.....	.....
Madera	311	3,083	22	.....	.....	.....
Mariposa	13,990	113,878	891	261	14,177	47
Modoc	.....	.....	.....	.....	.....	.....
Mono	338	6,021	42	.....	.....	.....
Monterey	117	4,424	34	.....	.....	.....
Nevada	274,930	2,805,162	37,414	3,826	216,552	9,516
Placer	36,845	134,647	5,770	.....	.....	.....
Plumas	18,838	63,040	365	.....	.....	.....
Riverside	1,077	10,693	147	.....	.....	.....
San Bernardino	28,021	188,620	10,720	.....	.....	.....
Shasta	49,205	265,356	2,031	1,743	78,668	533
Sierra	65,411	581,845	4,663	269	21,800	69
Siskiyou	5,543	43,212	309	20	1,058	6
Trinity	27,670	231,761	3,448	10	2,179	22
Tuolumne	222,505	595,623	17,454	9,418	337,561	1,814
Yuba	154	1,857	22	.....	.....	.....
Total	1,993,821	8,559,802	140,194	46,072	2,183,405	24,954
Average value per ton	.....	$4.29	$0.04	.....	$47.39	$0.30

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ozs.*	*Short tons.*		*Fine ozs.*
Amador	83	$487	694	1,873	$11,076	78
Butte	.....	.....	.....	.....	.....	.....
Calaveras	43,485	66,003	102,394	4,752	8,403	599
El Dorado	.....	.....	.....	.....	.....	.....
Fresno	.....	.....	.....	.....	.....	.....
Imperial	46	5,082	74	.....	.....	.....
Inyo	16,814	28,739	460,146	726	187	13
Kern	293	6,265	2,622	2,126	4,217	58
Lassen	.....	.....	.....	.....	.....	.....
Madera	5	806	40	.....	.....	.....
Mariposa	729	1,761	275	.....	.....	.....
Modoc	16	527	9	.....	.....	.....
Mono	62	800	16,394	.....	.....	.....
Monterey	.....	.....	.....	.....	.....	.....
Nevada	6	351	94	3,336	35,889	405
Placer	6	165	58	.....	.....	.....
Plumas	1,198	570	5,000	.....	.....	.....
Riverside	34	537	14	.....	.....	.....
San Bernardino	766	10,004	56,649	3,250	10,128	363
Shasta	385,589	626,056	623,289	1,417	2,672	94
Sierra	.....	.....	.....	.....	.....	.....
Siskiyou	.....	.....	.....	5,000	1,068	7
Trinity	.....	.....	.....	50	118	2
Tuolumne	.....	.....	.....	2	7,609	2,463
Yuba	.....	.....	.....	.....	.....	.....
Total	449,132	748,073	1,267,752	22,532	81,367	4,082
Average value per ton	.....	$1.67	$1.56	.....	$3.61	$0.10

[a] Includes 10 tons of ore sent to concentrating mills.

Average recovery from bullion and concentrates: Gold, $5.39; silver, $0.05.

Reports were received from 658 producing mines in California in 1914, as shown in the following table:

Number of producing mines in California, classified by chief product in 1914, by counties.

County.	Placer mines.					Deep mines.						Total mines reporting production.
	Hydraulic.	Dredging.	Drift.	Surface.	Total.	Gold.	Copper.	Silver.	Silver-lead.	Lead.	Total.	
Amador			4	2	6	16	1				17	23
Butte	2	21	7	6	36	4					4	40
Calaveras	4	4	7	7	22	21	3				24	46
Del Norte	2			3	5							5
El Dorado	1		7	13	21	9					9	30
Fresno						4					4	4
Humboldt	11			1	12							12
Imperial						2					2	2
Inyo						11	1	2	3	7	26	26
Kern	2				2	26					26	28
Lassen						1					1	1
Madera				1	1	4					4	5
Mariposa				2	2	15	1				16	18
Merced		1			1							1
Modoc						2					2	2
Mono						5		1			6	6
Monterey						1					1	1
Nevada	3		3	5	11	27					27	38
Placer	1	3	23	9	36	5	1				6	42
Plumas	4		4	15	23	8	1				9	32
Riverside						4					4	4
Sacramento		11	1		12							12
San Bernardino				1	1	10	7	4	1	2	24	25
Shasta		3		6	9	18	4				22	31
Sierra	6		10	8	24	14					14	38
Siskiyou	39	2	1	6	48	19					19	67
Stanislaus		1			1							1
Trinity	30	2	1	9	42	15					15	57
Tuolumne						33					33	33
Yuba		12	2	11	25	3					3	28
Total	105	60	70	105	340	277	19	7	6	9	318	658

In the following section on the production by counties, the details of the more important changes in the metal-mining industry in California are noted. The gold-mining industry continues prosperous and the yield of gold is increasing, but the producing mines have been showing a serious decrease in number during the last two years. There were 658 producing mines of all kinds in California in 1914, which was 138 less than in 1913, and in 1913 there were 245 mines less than in 1912; so that the producing mines in the State numbered 383 less in 1914 than in 1912. This is mainly due to the cessation of the prospecting and developing of new properties, as was explained in the report for 1913. Other contributory conditions arising since then are the passage by the California legislature of certain laws affecting labor which have tended to discourage investment and operation of properties. The so-called "blue sky" law regulating the formation of corporations has very materially lessened the number of new mining companies organized to develop properties. The laws lessening the hours of labor, and those providing strictly for compensation in case of death or injury and for the insurance by the companies of their employees have tended strongly to make the working of low-grade ores impossible. These laws have, therefore, lessened the number of men employed and have curtailed the capacity of reduction plants. In some places, as along Trinity River, the

owners of small mines, held by possessory rights, have been urged to patent their claims, and numbers have quit work. In other places, as along parts of Yuba River, where hundreds of miners have freely worked during portions of the year since California was settled, large companies have purchased the lands and the miners have been compelled to cease operations. These conditions, as well as those described in the report for 1913, have to some extent discouraged mining investment and the opening and equipping of new properties. There is a demand for "going" mines, which are seldom for sale, but little or no demand for those in the "prospect" or developing stage. The result is a gradual but evident decrease in the number of productive mines in the State.

PRODUCTION BY COUNTIES.[1]

AMADOR COUNTY.

Number of mines producing in Amador County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, and copper produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	36	649,693	$2,420,161	21,420	10,000	$2,434,659
1906	26	579,599	2,260,376	21,760	8,648	2,276,624
1907	36	444,341	2,116,182	20,477	5,300	2,130,757
1908	34	422,155	1,876,174	24,980	55,788	1,896,777
1909	51	480,674	2,298,785	32,118	113,995	2,330,305
1910	50	577,934	2,646,246	36,883	151,480	2,685,401
1911	50	656,806	2,832,395	54,526	227,848	2,889,775
1912	44	737,148	2,796,194	52,093	175,542	2,857,195
1913	29	640,593	2,901,898	29,962	19,015	2,922,942
1914	23	630,993	3,082,002	30,800	5,218	3,099,728
Increase (+) or decrease (−) in 1914	−6	−9,600	+180,104	+838	−13,797	+176,786

[1] For reference to United States Geological Survey publications on the mining districts of California, see Hill, J. M., The mining districts of the western United States: U. S. Geol. Survey Bull. 507, 1912.

There were 6 less mines producing in Amador County in 1914 than in 1913, and the quantity of ore decreased by 9,600 tons, yet the output of gold was increased by $180,104. There was also a small increase in silver, but a decrease in copper. The total increase in the value of all metals for the year in the county was $176,786. Amador County continued to lead all other counties of the State in quantity of ore treated with 630,993 tons in 1914, exceeding the next county in rank in this respect, Shasta, by 194,782 tons. Amador County is second in rank among the counties in quantity of gold produced in 1914, being exceeded by Nevada County by $219,946. The quantity of gold produced in Amador County in 1914 was 149,091.85 fine ounces, valued at $3,082,002. The value of the silver was $17,032, and of the copper $694. There were 6 productive placer mines in the county in 1914, and 17 deep mines, 23 in all.

Of the total output of ore, 75 tons of copper ore and 8 tons of siliceous ore were shipped to the smelter, and 629,037 tons (99.7 per cent of the total quantity) were treated in the gold and silver mills. From this milling ore $1,995,787 in gold and 20,740 ounces of silver, valued at $11,469, were saved as bullion, an average value per ton

of $3.17 in gold and of $0.018 in silver. From this milling ore was obtained 14,091 tons of concentrates, which yielded $1,065,581 in gold, an average of $75.62 a ton, and 9,228 ounces of silver, valued at $5,103, an average of 36 cents a ton, a total average value of $75.98 a ton. The extraction of gold from bullion and concentrates combined was $3,061,368, an average of $4.87 a ton, and the recovery of silver was $16,572, an average of $0.026 a ton. The value of the total yield of gold and silver from milling ore was therefore $3,077,940, an average value of $4.90 a ton. In addition there were 1,873 tons of old tailings treated, yielding $11,076 in gold and 78 ounces of silver, valued at $43, a total of $11,119, or an average per ton in gold of $5.91, and in silver of $0.023. The ore shipped to smelters yielded $487 in gold and 694 fine ounces of silver, valued at $384, in addition to the copper. The yield of the placers in the county was 438.81 fine ounces of gold, valued at $9,071, and 60 ounces of silver, valued at $33. Of the placers, 4 were drift mines and 2 were surface sluicing mines. The decrease of gold from placers was $23,979 in 1914, as compared with 1913.

The most important deep mine producer at Amador City is the Bunker Hill Consolidated, which is opened by an incline shaft and is equipped with a 40-stamp mill and 28 Frue vanners. At the tailings plant connected with the mine about 200 tons daily are handled from the mill. About 80 tons of sand are separated and leached, and from the 120 tons, which are concentrated, 5 tons of crude concentrates are obtained and cyanided. The Keystone Mines Co. operated its mine throughout the year, but the mill was only run 5½ months. The mine is opened by a 2,600-foot incline shaft, a 200-foot adit, and 5,610 feet of drifts. The mine has a 20-stamp mill. The Original Amador Consolidated Mines Co. is another large producer at this place. The Defender mine, at Defender, has a 10-stamp mill, and the Deadwood and Desoto mine is a small producer at the same place. The Fremont Consolidated Mining Co. is an important gold producer at Drytown and works as one property the Gover, North Gover, Loyal Lode, and Fremont mines. There are two incline shafts of 1,550 and 2,400 feet, respectively. The ore is crushed under 40 stamps and amalgamated, and the concentrates from the Frue vanners are shipped to the smelter for treatment. The tailings are handled by a canvas plant. The Ione Coal & Iron Co. did not operate its property at Ione in 1914, but a small quantity of ore was treated in the 4-stamp mill.

In both ore produced and yield of metal the deep gold mines at Jackson and Sutter Creek are the most important in the State. The Argonaut, at Jackson, has a 63-degree incline shaft 4,335 feet deep and is equipped with a 40-stamp mill, which was operated 23.5 hours a day throughout the year. The Hardenberg, which was reopened and became again productive in 1913, made some output in 1914, but has been closed since. The Kennedy, one of the most productive of the deep mines of California, and having the deepest vertical shaft, is equipped with a 100-stamp mill. The Zeila, for many years a producer, made some output in 1914, but in that year all operations were suspended and the machinery was sold. The Central Eureka, at Sutter Creek, is opened by an incline shaft 3,100 feet deep. The mill was idle from January 1 to March 13, 1914, after which 20 stamps were operated, and during the latter half of

the year the remaining 20 stamps were also dropped, making 40 stamps in all. The South Eureka, at the same place, one of the larger producers, has an 80-stamp amalgamation and concentration mill. Considering Jackson and Sutter Creek as one district, the combined mines of that section made an output in 1914 of $2,113,098 in gold and $12,674 in silver, a total of $2,125,772 in gold and silver. The Plymouth Consolidated mines, at Plymouth, were undergoing development from January to June while the shaft was being sunk from the 1,600-foot to the 2,000-foot level. A mill was built in 1914 and was operated from August to December, inclusive. It has 30 stamps, 2 Hardinge mills, and 30 vanners. In the last two months of the year the shaft was completed to 2,200 feet in depth. The first 1,520 feet is vertical, the remainder being on an incline.

There are a few placer mines worked near Volcano, including the Clapboard Gulch, Denend, Humbug Diggings, and Giuliani; and among the nonproducing mines of the county, drifting and crosscutting was carried on in the Treasure, at Amador City, for 325 days and prospecting still continues. There are no reduction works on the property.

BUTTE COUNTY.

Number of mines producing in Butte County, Cal., quantity of ore sold or treated, 1905–1914, and total gold, silver, copper, and lead produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	82	1,058	$2,590,886	10,907	.....	.....	$2,599,244
1906	63	682	3,016,747	16,199	.....	.....	3,027,600
1907	72	.....	2,786,840	13,587	.....	.....	2,795,807
1908	75	1,215	3,139,398	23,978	.....	.....	3,152,106
1909	49	1,316	2,987,079	13,856	.....	.....	2,994,284
1910	76	13,578	2,487,791	11,851	.....	659	2,494,220
1911	82	2,575	2,323,396	9,627	.....	.....	2,328,498
1912	77	3,326	2,346,229	9,053	.....	.....	2,351,796
1913	61	13,559	2,269,849	8,548	30	362	2,275,033
1914	40	409	1,697,120	6,389	.....	.....	1,700,653
Increase (+) or decrease (−) in 1914	−21	−13,150	−572,729	−2,159	−30	−362	−574,380

In 1914 Butte County showed a decrease in gold of $572,729 and in silver of 2,159 ounces, compared with 1913. There were 21 fewer producing mines than in 1913. The productive mines of the county comprised 2 hydraulic, 21 dredges, 7 drift, 6 surface, and 4 deep mines, a total of 40. The dredges produced $1,637,515 in gold in 1914, and $2,122,926 in 1913, a decrease of $485,411 for 1914. There were 4 less dredges in operation than in 1913. As there were 3 less in 1913 than in 1912, there has been a decrease of 7 dredges in operation in the last two years. This is mainly due to the older companies having worked out their available ground for dredging. The hydraulic mines of the county produced $163 more in 1914 than in 1913; the drift mines $162 less; and the sluicing mines $55,414 less. The total gold output from placers of all kinds in 1914 was $1,692,959, as compared with $2,233,783 in 1913, a decrease of $540,824. The output of gold from deep mines was $4,161 in 1914, as compared with $36,066 in 1913, a loss of $31,905. Butte is the third county

in rank in output of dredge gold, being exceeded by both Yuba and Sacramento counties. The following table shows the output of gold from the Oroville dredging field for several years, with the annual increase or decrease:

Mine production of gold of Oroville dredging district, California, 1903–1914, with increase (+) or decrease (−), by years.

Year.	Production.	Increase (+) decrease (−).
1903	$1,329,998	.....
1904	1,632,507	+$302,509
1905	2,261,887	+ 629,380
1906	2,768,782	+ 506,895
1907	2,697,092	− 71,690
1908	3,043,151	+ 346,059
1909	2,743,232	− 299,919
1910	2,099,628	− 643,604
1911	1,987,294	− 112,334
1912	2,080,229	+ 92,935
1913	1,918,050	− 162,179
1914	1,422,407	− 495,643

This table applies to the dredges in the Oroville district proper only, there now being in Butte County 5 other dredges in "outside" districts. The combined output of these outside dredges in 1914 was $215,108, as compared with $204,876 in 1913, with $191,767 in 1912, with $264,470 in 1911, and with $289,607 in 1910.

In 1914 the following companies were operating in the Oroville field, each with 1 machine unless otherwise noted: El Oro, Ora Vista, Indiana, Natomas Consolidated of California (3), Ophir (2), Oroville Dredging (Ltd.) (2), Oro Water, Light & Power Co. (4), Pacific, Oroville Leasing Co., and Viloro Syndicate. Only one of the dredges of the Ophir Co. was operated in 1914. There were 16 dredges at work as compared with 20 in 1913. The old Pennsylvania dredge was operated by the Oroville Leasing Co. up to September, when it became the property of the Oroville Union Gold Dredging Co., which did not begin to make any production until January 29, 1915.

The companies at Butte Creek and Honcut, outside the Oroville district, are the Butte Creek Consolidated, Drexler, Pacific, Kentucky Ranch, and Honcut.

As to other placer operations in the county, there was some sluicing at Berdan and Brush Creek, and the Cherokee Mining Co. at Cherokee hydraulicked its gravel beds. A few small placers were productive at Inskip, and one drift mine was productive at Lovelock. At Magalia and Nimshew only sluicing operations were carried on, and there was considerable gravel washing carried on near Oroville in addition to the dredging, both by whites and by Chinese.

The few deep mines operating in the county are all small producers. These are the Clearwater, at Clipper Mills; Crystal Peak, at Enterprise; Triumph, at Lumpkin; and Banner, near Oroville.

The Royal Drift Mining Co., at Berdan, is still trying to develop the river channel. The Edel Mining Co., at Enterprise, carried on some drifting and development work. The Indian Springs Channel Mining Co. had 10 men at work drifting to tap the old channel. On the Burlington, at Forbestown, no new work was done, the property being under bond.

CALAVERAS COUNTY.

Number of mines producing in Calaveras County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, and copper produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	56	547,972	$1,780,485	105,693	3,666,810	$2,416,345
1906	48	583,207	1,644,234	110,597	5,082,320	2,699,221
1907	77	295,441	1,097,974	82,454	4,386,243	2,029,643
1908	59	481,669	1,378,511	118,353	4,473,030	2,031,678
1909	94	566,665	1,440,511	137,342	5,416,315	2,216,050
1910	71	436,263	1,147,705	155,248	7,302,331	2,158,935
1911	78	482,983	1,112,315	126,476	5,681,200	1,889,497
1912	70	430,128	962,145	115,037	6,089,819	2,037,713
1913	46	414,006	1,175,208	101,120	5,823,226	2,138,884
1914	46	407,746	1,336,875	109,299	4,395,444	1,981,911
Increase (+) or decrease (−) in 1914		−6,260	+161,667	+8,179	−1,427,782	−156,973

Calaveras is one af the Mother Lode counties. The same number of mines operated productively in the county in 1914 as in 1913, but the quantity of ore mined and treated decreased by 6,260 tons. There was an increase of gold of $161,667 and of silver of 8,179 ounces, but the decrease of copper was 1,427,782 pounds. The total value of all metals decreased by $156,973 in 1914, as compared with 1913. The value of the output of copper in the county in 1914 was $584,594, as compared with $902,600 in 1913, a decrease of $318,006. In 1914 productive mines to the number of 46 reported; 21 deep gold mines, 3 copper mines, 4 hydraulic, 4 dredges, 7 drift, and 7 surface placers. The placer mines of the county produced $431,302 in gold, and 1,794 ounces of silver, valued at $992. The hydraulic product was $3,746 in gold; dredges, $390,390; drift mines, $31,929; and surface placers, $5,237.

The average value per ton of the 359,509 tons of milling ore treated at gold and silver mills in the county in 1914 was only $2.32 in gold and silver, compared with $1.90 in 1913. The average is the lowest of the Mother Lode counties. The output of ore sold or treated in Calaveras County in 1914 was 407,746 tons, which yielded 43,807.09 fine ounces of gold, valued at $905,573; 107,505 fine ounces of silver, valued at $59,450; and 4,395,444 pounds of copper, valued at $584,594. The placer output was 20,864.23 fine ounces of gold, valued at $431,302, and 1,794 fine ounces of silver, valued at $992. The output of the county in 1914 in gold, silver, and copper was valued at $1,981,911.

There were 359,509 tons of ore treated at gold and silver mills, from which was obtained $467,145 in gold in bullion, or $1.30 a ton, and 2,977 fine ounces of silver, valued at $1,646. The total saving in bullion was valued at $468,791, or $1.305 a ton. From this 359,509 tons of ore were obtained 15,212 tons of concentrates, yielding $364,022 in gold, and 1,535 fine ounces of silver, valued at $849, an average of $23.93 in gold and $0.06 in silver, or a total average value per ton of $23.99. The milling ore yielded $831,167 in gold; the average recovery per ton in gold was $2.31 and in silver it was

1 cent; the total gold and silver recovery was, therefore, $2.32 a ton. There were 43,485 tons of smelting ore sold or treated, yielding $66,003 in gold, and 102,394 fine ounces of silver, valued at $56,624, or an average value per ton of $1.52 in gold and $1.30 in silver, or $2.82 a ton in gold and silver; and 4,395,444 pounds of copper, valued at $584,594. The total value of the smelting ore was $707,221, or $16.26 a ton.

The leading mining section of Calaveras County is at Angels. In 1914 the deep-mine output of the camp was $404,010 in gold and $1,447 in silver, as compared with $405,621 in gold and $4,044 in silver in 1913, and $405,803 in gold and $5,684 in silver in 1912. The principal producing mines are the Angels, Columbia, Lightner, and Utica. The Lightner closed down in July, 1914. The Utica has 100 stamps in its two mills. The largest producer in the county is the Penn Mining Co., at Campo Seco. The values carry mainly in copper, but with considerable gold and silver. This mine is opened by a 1,500-foot incline shaft and winze, and in 1914 the winze was sunk from the 1,750-foot to the 2,300-foot level. During the year the 80-ton blast furnace was operated 73 days and the 120-ton reverberatories 312 days. In addition to the output of matte, considerable cement copper was produced from the mine water. The Calaveras Copper Co. is another copper producer in the county. A small quantity of ore was treated by the Bonnie Blue, at Felix; but the mine has closed down. The California-Rand Co. is a small producer at Glencoe. The Melones, the second largest producer in the county, is opened by a tunnel a mile long and it has 1,100 feet of raises to the surface and an incline shaft 870 feet deep. The mine is equipped with 100 stamps, Wilfley tables, and cyanide plant, and completed a sand-slime plant after the close of 1914. The Brown and the Napoleon mines are producers near Milton. The Comet mill, at Railroad Flat, was only operated a few weeks in the year. At the Mohawk, at the same place, the old shaft was opened and retimbered and unwatered, but only a small output was made. The Duchess, at Vallecita; Benson, at Valley Springs; Deer Foot, North Star, Star, and Union Development Co., at Westpoint, are all small deep-mine producers. The productive placers in the county are at Comanche, Jenny Lind, Sheep Ranch, Mokelumne Hill, San Andreas, and Vallecita. At Comanche, the Oro Water, Light & Power Co. is operating a dredge. At Jenny Lind, 3 dredges were at work in 1914, those of the Butte Dredging Co. and the Calaveras Dredging Co., and that of the Isabel Gold Dredging Co., which was later taken over and operated by the Ivy L. Borden Co. Some little bedrock cleaning was done 3 miles east of Jenny Lind on the old North Hill hydraulic property. At Mokelumne Hill are the Clover Leaf drift, Eclipse, Green Mountain drift, Stockton Ridge drift, and a few smaller mines, with a combined gold output of $29,381. Development work was carried on the entire year on the Omega and Golden Reward mines, at Mokelumne Hill, and also on the Mammoth, at Railroad Flat; and all these mines were expected to become productive in 1915.

ELDORADO COUNTY.

Number of mines producing in Eldorado County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, and copper produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	58	36,708	$385,596	3,253	160,000	$412,521
1906	61	31,818	431,746	4,015	.....	434,436
1907	61	33,781	319,177	3,486	.....	321,478
1908	64	10,521	342,033	10,385	.....	347,537
1909	48	27,431	238,284	2,498	.....	239,583
1910	64	17,383	171,304	1,791	.....	172,271
1911	56	11,444	133,967	1,905	.....	134,977
1912	51	8,871	105,565	1,371	.....	106,408
1913	26	16,798	62,688	414	703	63,047
1914	30	18,488	133,886	1,183	.....	134,540
Increase (+) or decrease (−) in 1914	+4	+1,690	+71,198	+769	−703	+71,493

Eldorado, which is one of the five Mother Lode counties, in 1914 produced 6,476.74 fine ounces of gold, valued at $133,886, and 1,183 ounces of silver, valued at $654, a total of $134,540. There was an increase of 1,690 tons of ore treated, and an increase of $71,198 in gold and of 769 ounces of silver. The increase in total value of the metallic output of the county in 1914, as compared with 1913, was $71,493. The ore treated at gold and silver mills, amounting to 18,488 tons, yielded in bullion $62,683 in gold, or an average of $3.39 a ton, and 384 ounces of silver, valued at $212, or an average of $0.01 a ton, the total recovery in bullion being valued at $62,895, or an average per ton of $3.40 in gold and silver. There were 365 tons of concentrates derived from the milling ore, which yielded $28,341 in gold and 544 ounces of silver, valued at $301, a total value of $28,642, or $78.47 a ton in gold and silver. The milling ore yielded, therefore, in bullion and from the concentrates a total of $91,024 in gold, or an average per ton of $4.92, and silver valued at $513, or $0.03 a ton, or a total value of gold and silver of $91,537, or $4.95 a ton.

The placer mines of the county yielded 2,073.45 fine ounces of gold, valued at $42,862, and 255 ounces of silver, valued at $141. Of this placer gold, $3,327 came from hydraulic mines, $5,867 from drift mines, and $33,668 from surface placers. There were 30 producing mines in the county, of which 21 were placers and 9 were deep mines. There were no mines, either deep or placer, of any great importance operated in Eldorado County in 1914, many of the formerly well known properties now being idle. Of the deep mines working productively may be mentioned the Marigold and the Frog Pond Consolidated, at Garden Valley; the Morning Star and the Lincoln, at Georgetown; the Stillwagon, at Omo Ranch; and the Placerville, at Placerville. The Guildford Mining Co., at Placerville, worked the Poverty Point mine, which is developed by a 3,380-foot tunnel. In 1914 the development work consisted of 540 feet of drifts, 720 feet of upraises, and 429 feet of crosscuts. The mill has 15 stamps, 3 Wilfley tables, and 2 Frue vanners.

The productive placers were the Slug Gulch, at Fairplay; Manhattan, at Garden Valley; Blue Rock, Gold Bug, Otter Creek, Noble, and Tipton, at Georgetown; Grizzly Flat, at Grizzly Flat; Jinkerson, at Indian Diggings; Coffin & Reid, Hosking, and Chili Ravine, at Placerville; Deadman Flat, Pilot Knob, and Dividend, at Rescue; and Fort Jim, at Smith Flat.

DEL NORTE AND HUMBOLDT COUNTIES.

There are only 5 productive mines in Del Norte County, 2 of which are hydraulic and 3 are surface mines. Their combined output was $2,035 in gold and 16 ounces of silver, valued at $9, a total of $2,044. The operating mines in 1914 were all at Crescent City.

Humboldt County has no report of any deep mines in 1914, but has 12 placers, 11 of which are hydraulic. These are all at Orleans, except one at China Flat. The total output in the county in 1914 was $18,686 in gold and 103 ounces of silver, valued at $57, a total of $18,743, a decrease of $7,000. The producing hydraulic mines at Orleans are the California Mining & Dredging Syndicate, Independence, Jungle, Prospect Hill, Reynolds Creek, Rocky Point, Roselino, Rough & Ready, Salstrom, and Ten Eyck. At China Flat is the Clover Flat Mining Co.

INYO COUNTY.

Number of mines producing in Inyo County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, copper, lead, and zinc produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	24	8,907	$91,501	84,622	151,606	447,723	.....	$187,307
1906	16	3,401	19,449	19,937	4,145	208,018	.....	45,464
1907	17	17,684	57,241	67,333	15,587	2,596,399	233,550	256,186
1908	25	39,440	308,873	58,302	3,690	1,110,952	.....	386,920
1909	34	79,625	457,846	90,609	31,722	1,490,649	.....	573,185
1910	33	52,963	408,509	239,982	58,047	2,866,894	.....	671,614
1911	50	101,662	574,945	86,185	29,504	1,329,756	2,624,719	833,759
1912	51	70,615	369,758	73,685	45,033	997,999	4,345,591	767,261
1913	44	38,064	237,310	226,579	114,213	3,246,432	963,571	588,670
1914	26	41,189	265,734	466,575	292,812	4,205,154	389,471	746,558
Increase (+) or decrease (−) in 1914	−18	+3,125	+28,424	+239,996	+178,599	+958,722	−574,100	+157,888

There were 26 productive mines in Inyo County in 1914, all deep mines, or 18 less than in 1913. Of these mines 11 were gold, 1 copper, 2 silver, 5 silver-lead, and 7 lead. The total value of the output for 1914 was $746,558, which is $157,888 more than in 1913. The value of the gold was $265,734, or $28,424 more than in 1913. The silver amounted to 466,575 ounces, valued at $258,016, which made this county rank second to Shasta in yield of silver. The increase in output of silver in 1914 was 239,996 fine ounces, as compared with 1913, or $121,162 in value. The output of copper in 1914 was 292,812 pounds, valued at $38,944, an increase in quantity of 178,599 pounds and in value of $21,241. The lead amounted to 4,205,154

pounds, valued at $164,001, as compared with 3,246,432 pounds, valued at $142,843, in 1913, an increase in quantity of 958,722 pounds and in value of $21,158. The decrease in zinc in 1914, as compared with 1913, was 574,100 pounds in quantity and $34,097 in value.

There were treated in 1914 in Inyo County 41,189 short tons of ore, of which 24,375 tons were siliceous ore, 22 tons were copper ore, 587 tons were lead ore, 92 tons were silver ore, and 16,113 tons were silver-lead ore. The deep mines in 1914 yielded 12,854.88 fine ounces of gold, valued at $265,734, and 466,575 fine ounces of silver, valued at $258,016. Of the gold, 11,464.62 fine ounces, valued at $236,995, were obtained from siliceous ore; from copper ores were obtained 0.44 fine ounces, valued at $9; from lead ores, 26.37 fine ounces, valued at $545, from silver-lead ores, 1,344.63 fine ounces, valued at $27,796; and from silver ores, 18.82 fine ounces, valued at $389. No zinc ores were reported in 1914. The production of silver from siliceous ore was 6,429 fine ounces, valued at $3,555; from copper ores, 1,224 fine ounces, valued at $677; from lead ores, 16,237 fine ounces, valued at $8,979; from silver-lead ores, 438,568 fine ounces, valued at $242,528; and from the silver ores, 4,117 fine ounces, valued at $2,277. The siliceous ore, therefore, yielded $240,550 in gold and silver; the copper ores $686; the lead ores, $9,524; the silver-lead ores $270,324; and the silver ores $2,666, a total of $523,750 in gold and silver for the county.

The Cashier Gold Mining Co., at Ballarat, the largest producer there, has a 5-stamp mill, and a cyanide plant was put in after the close of 1914. The Harrisburg Mines Co. leased the property in 1914. The Gem group, also at Ballarat, made a small output. The Fish Springs Hill and Lockrie & Black, at Big Pine, made small outputs. At Darwin the producers were the California, Christmas Gift, Henrietta, and a few smaller mines. The Black Eagle also made a small production. The Ygnacio mine, at Keeler, produced small quantities of lead and copper, and at the same place the Ella, Shady and Perseverance, Farrington, Golden Gate, and Ventura were small producers. The largest producer here, and in the county, was the Cerro Gordo Mining Co., which produced a great deal of silver and some copper, lead, and zinc. This mine has a vertical shaft 900 feet deep and a winze below this to a depth of 1,150 feet. About 5,000 feet of development work has been done in the mine and much new equipment was purchased and installed in 1914. The sulphide ores were shipped to the smelters at Salt Lake City. Spear Brothers at the same place also shipped considerable lead-silver-zinc ore to the Salt Lake City smelters. At Lone Pine ore from the Nellie H. was worked in a roller mill. The Skidoo Mines Co., at Skidoo, one of the larger producers of the county, has a 10-stamp mill and 50-ton cyanide plant for sand leaching. Work was started in 1914 to increase the mill to a 60-ton capacity, to install concentrators, and to increase the capacity of the cyanide plant. The Harrisburg Mines Co. also made some production at Skidoo. The Tecopa Consolidated Co., at Tecopa, operated the Granite and the Noonday mines and shipped their lead ore to Salt Lake City smelters and the zinc ore to the Bartlesville Zinc Co., Oklahoma. Considerable silver was also produced at this property. The Arcturus, or Ibex, was also productive in this district. The Keane Wonder is among the larger producers in this county.

KERN COUNTY.

Number of mines producing in Kern County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, copper, and lead produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	46	252,776	$1,121,370	170,469	.....	.....	$1,224,333
1906	36	146,076	806,117	193,288	.....	.....	935,620
1907	40	236,853	878,798	130,353	.....	.....	964,831
1908	44	259,968	827,087	182,170	144	.....	923,656
1909	53	242,104	654,799	195,488	.....	.....	756,432
1910	51	197,550	619,974	64,891	.....	569	655,040
1911	53	180,687	557,471	11,005	33,224	600	567,484
1912	41	168,226	830,420	18,667	1,064	20,011	842,976
1913	39	147,131	649,712	19,621	3,432	159	662,102
1914	28	177,234	594,337	14,470	.....	6,641	602,598
Increase (+) or decrease (−) in 1914	−11	+30,103	−55,375	−5,151	−3,432	+6,482	−59,504

Of the total of 28 mines reporting production in 1914 in Kern County 2 were placers, the other 26 being deep gold mines. The total production of gold in the county in 1914 was 28,751.05 fine ounces, valued at $594,337, as compared with 31,429.82 fine ounces, valued at $649,712 in 1913, a decrease in quantity of 2,678.77 ounces and in value of $55,375. The value of the silver was $8,002, as compared with $11,851 in 1913, a decrease of $3,849. There were small quantities of copper and lead produced in 1913; and 6,641 pounds of lead, valued at $259, were produced in 1914, but no copper.

There were treated 177,234 tons of siliceous ore in 1914, of which 174,815 tons were treated at gold and silver mills and 293 tons were sent to smelters; there were also 2,126 tons of old tailings treated. The yield in bullion from the 174,815 tons of ore treated at gold and silver mills was $577,913 in gold, an average of $3.31 a ton, and 10,853 fine ounces of silver, valued at $6,002, a total bullion value of $583,915 in gold and silver, with an average value per ton of $3.34. From this ore were derived 71 tons of concentrates yielding $2,642 in gold, and 917 fine ounces of silver, valued at $507, a total value of $3,149 in gold and silver, with an average value per ton of $44.35. The 293 tons sent to smelters yielded $6,265 in gold and 2,622 fine ounces of silver, valued at $1,450, a total value of $7,715 in gold and silver, or an average of $26.33 a ton in gold and silver. The total yield of the county in gold and silver from deep mines was $599,028, an average of $3.38 a ton of ore treated. Two placers yielded 159.64 fine ounces of gold, valued at $3,300, and 20 fine ounces of silver, valued at $11; these were both hydraulic mines.

The most productive district in this county is Randsburg [1] (which includes Johannesburg). In 1914 the mines in these camps produced 155,092 tons of ore, which yielded $441,034 in gold and $3,971 in silver, as well as 6,641 pounds of lead, valued at $259, a total value of $445,264, as compared with $508,009 in 1913, $748,223 in 1912, and $509,696 in 1911. It is to be noted that the quantity of ore increased 19,591 tons in 1914, as compared with 1913, but that the

[1] Hess, F. L., Gold mining in the Randsburg quadrangle, California: U. S. Geol. Survey Bull. 430, pp. 23–47, 1910.

total value fell off by $62,745, showing a decrease in the average value of the ores mined and treated. The Shipsey and a few other small mines were operated at Johannesburg. Among the producers at Randsburg, the Baltic Leasing Co. operated its mine throughout the year but the 10-stamp mill and the 50-ton cyanide plant only a portion of the time. The Consolidated Mines Co. took practically all its ore from the Good Hope mine. The Garfield, Josephine, Lucky Star and Margenetta, Nancy Hanks, Stanford Mining & Reduction Co., and Windy all produced, but none of them in large quantity. The Yellow Aster Mining Co., the largest producer in the county (and in southern California), mined most of its ore by "glory hole" work in 1914. This property has 2 mills, 1 of 100 stamps, and 1 of 30 stamps. A second 14-foot table was placed below the original one in each battery and they have greatly increased the plate savings. Steam was also replaced by electricity for power. As to non-producers in Randsburg, the Little Butte did not resume operations in 1914, as it expected to do. The bond and lease on the Phoenix were given up. On the Sidney group development work was carried on, but no ore was milled. At Caliente a small production was made from both the Golden Jackrabbit and the Kern County-Tonopah mines, but the latter has since closed down. The Venus was a small producer at Havilah. The ore from the Early Sunrise, at Isabella, was treated at a mill in Keyesville. The Mammoth Mountain, at the same place, is opened by an adit 1,500 feet long and 810 feet from the portal by a 215-foot shaft. There are 5 tunnels in the property, each about 800 feet long. During the year the 10-stamp mill was moved to the adit mouth. The Keys and the Three Chimneys mines, also at Isabella, were productive in 1914. A small output was made by the Seder Black Bob at Kern. The Barbarossa and the Zenda mines were productive at Loraine. The latter mine is worked by the "glory hole" method and has a 50-ton cyanide plant. During the year the mill was changed to an all sliming plant by the addition of a tube mill and agitators. The Mojave Consolidated Gold Mines, at Mojave, is opened by 2 shafts, 900 feet and 400 feet deep, respectively, and is equipped with a 20-stamp mill and a 75-ton cyanide plant. A new surface tramway was built in 1914. Near Mojave, on Last Chance Gulch, some drift mining has been commenced by the Kern Placer Mining Co. There are a number of deposits in that vicinity, and a large amount of work has been done by individuals. In times past the old prospectors came there with dry washers, taking the product to some of the many water holes and panning out the gold; they averaged about $3 a day. The ancient river channel is up on the benches, where, it is claimed, there are some large deposits, and the gulches were rich from the washings from these benches. Residents state that a large ancient river bed may be traced for several miles by these gravel points. The black sand carries some platinum—in some places over an ounce per ton. The richer the sand in gold, the more platinum is found. The wash is full of bowlders, which are smooth and water worn. The Jeanette group of deep mines at Piute made a small output in 1914. The Tropico, at Rosamond, has a 10-stamp mill and a 30-ton cyanide plant, and during the year the slime plant was enlarged and improved. The mill was run on full time until September on ore, after which tailings were treated for the rest of the year. The mine was worked for the full year.

The only productive placers in the county were those of the Gold Placer Mining Co., 2 miles from Randsburg, where experimental hydraulic work is being done; and the Bonanza and Deep Diggings are being hydraulicked at Red Rock Canyon and adjoining gulches, in Red Rock district. Work was formerly done in this district by dry-washing methods. Among the nonproducers of the county, the Bishop Creek Milling Co. devoted most of the season to constructing its 50-ton cyanide plant, in connection with the 10-stamp mill. The cyanide plant was completed in December.

MARIPOSA COUNTY.

Number of mines producing in Mariposa County, Cal., quantity of ore treated or sold in 1905–1914, and total gold, silver, and copper produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	27	88,316	$433,370	6,763	12,541	$439,411
1906	25	64,511	366,394	5,040	.....	369,771
1907	24	51,139	405,498	6,288	7,984	411,245
1908	27	53,972	439,862	8,928	36,757	449,446
1909	34	52,103	396,465	5,247	.....	399,194
1910	38	42,703	317,580	4,377	.....	319,944
1911	32	18,196	172,532	2,623	13,528	175,613
1912	38	21,094	160,541	11,051	300,062	216,847
1913	20	20,671	171,034	12,301	439,168	246,535
1914	18	14,719	131,458	1,224	170,241	154,777
Increase (+) or decrease (−) in 1914	−2	−5,952	−39,576	−11,077	−268,927	−91,758

Mariposa, one of the Mother Lode counties, showed a decrease in its metallic output in 1914, as compared with 1913, the largest decrease being in gold, $39,576, although there was a material falling off in silver as well. The decrease in total value for the year was $91,758. Eighteen mines reported production in 1914, which is 2 less than in 1913. Of these 16 were deep mines and 2 were placers. The placers were at Jerseydale and Whitlock. Most of the larger and most extensively developed properties in this county have been idle for several years, although equipped with hoisting and pumping machinery and reduction plants.

The deep mines produced 14,719 tons of ore, of which 729 tons went to the smelter. The 13,990 tons of ore that went to the gold and silver mills yielded $113,878 in gold as bullion, averaging $8.14 a ton, and 891 ounces of silver, valued at $493, the total gold and silver value of the bullion being $114,371, or an average per ton of $8.18. From this ore were also derived 261 tons of concentrates, which yielded $14,177 in gold and 47 ounces of silver, valued at $26, a total of $14,203. The concentrates, therefore, yielded $54.32 a ton in gold and $0.10 in silver, an average yield per ton of $54.42 in both gold and silver. The 729 tons of ore shipped to the smelter yielded $1,761 in gold, 275 ounces of silver, valued at $152, and 170,241 pounds of copper, valued at $22,642, an average value per ton for gold, silver, and copper of $33.68. The siliceous ore yielded on the plates and from the concentrates a total value of $128,574 in gold and silver, an average total value per ton of $9.19.

The Standard and a few other deep mines at Bagby made a nominal output in 1914. At Coulterville the Bondurant has a 10-stamp mill, but it was only operated 41 days in 1914, and the operations at the mine itself were confined to prospecting development work. The Champion made only a small output. Considerable gold came from the Virginia mine, a property formerly operated by the California Exploration (Ltd.) and the Mariposa Gold Mining Co. The Original Mill & Mining Co., at El Portal, was one of the larger producers of the county and was operated continuously from January to November, when shortage of water caused a temporary close-down. The mine has a 10-stamp mill and 3 Gates vanners. A good deal of drifting work was done during the year. At Jenny Lind the Early Revel and the Sweetwater mines reported small outputs, as did the East Lode Development Co., at Kinsley. The Trabuco and the Weston-Judkins Co. were small producers at Mariposa. The Mariposa Commercial & Mining Co., at Mount Bullion, did not work any of its many properties, but a few thousand dollars in gold were obtained by lessees working in old stopes. The Mountain King, at the post office of the same name, was operated the full year and kept 10 stamps of the 30 in the mill running. The Farmer's Hope and the North Whitlock Extension claims, at Whitlock, reported only nominal returns. Some copper was derived from the Pearce & Pearce mines, near Raymond. A few surface placers were productive at Jerseydale and Whitlock.

MONO COUNTY.

Number of mines producing in Mono County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, copper, and lead produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	13	23,444	$311,958	15,876	.....	.....	$321,547
1906	7	28,599	338,698	19,628	.....	.....	351,849
1907	8	32,363	383,971	45,147	.....	.....	413,768
1908	11	39,190	413,946	49,310	.....	2,429	440,182
1909	13	48,536	354,909	72,677	3,454	582	393,175
1910	12	24,913	435,724	17,391	.....	.....	445,115
1911	13	33,469	261,232	66,996	.....	44,289	298,733
1912	15	32,399	377,518	114,800	7,866	24,445	450,518
1913	7	21,953	147,271	38,515	79,323	.....	182,829
1914	6	400	6,821	16,436	3,812	.....	16,417
Decrease (—) in 1914	—1	—21,553	—140,450	—22,079	—75,511	.....	—166,412

Mono County showed the most marked decrease of the counties in the State in value of total output in 1914, as compared with 1913—ore, gold, silver, and copper were all greatly lessened in 1914. The decrease in the county was 91 per cent for the year. For many years large quantities of old tailings of good value have been treated in this county, but they have been all worked up apparently, for there was no report of production from them in 1914. There has been for some years only one really important producing mine in the county, the Standard Consolidated, at Bodie, and that was closed as worked out in the latter part of 1913, after a materially lessened output during the last year of work. In 1913 the decrease in total output of Mono County, as compared with 1912, was $267,689; in 1914 it was $166,412,

as compared with 1913; thus in two years the falling off in total output has been $434,101. The total yield of the county in 1914 was valued at $16,417.

There were 338 tons of crude ore treated at the gold and silver mills, yielding $6,021 in gold and 42 ounces of silver, valued at $23, a total of $6,044 and an average value per ton of $17.88 in gold and silver. No concentrates were produced and no old tailings were treated in 1914. There were 62 tons of ore shipped to smelters that yielded $800 in gold, 16,394 ounces of silver, valued at $9,066, and 3,812 pounds of copper, valued at $507, a total value of $10,373, or an average value per ton in all metals of $167.31.

The producing deep mines of the county in 1914 were the Rose of the West, at Benton; Casa Diablo and the Johnnie group, at Bishop; Don Alvarado, at Mono Lake; and Lakeview and the Silverado group, at Masonic. Among the nonproducing mines that of the Tanawah Mining Co., at Bridgeport, was developed to some extent by work on the tunnel. The mill was remodeled and a tailings plant was built. The 8-stamp mill and the 50-ton cyanide plant were not operated in 1914. Prospecting for dredging was carried on in Bacon and Spring gulches and in Wilson Creek, near Mono Lake. At the Serita mine a 500-foot tunnel was being cut to drain the property.

NEVADA COUNTY.

Number of mines producing in Nevada County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, and copper produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	65	325,266	$3,076,997	41,129	.....	$3,101,839
1906	56	276,602	2,658,420	36,147	.....	2,682,639
1907	52	227,288	2,162,083	25,522	22,111	2,184,010
1908	48	220,067	2,297,963	41,347	.....	2,319,877
1909	56	232,034	2,660,235	47,935	.....	2,685,161
1910	49	250,358	2,533,483	30,566	.....	2,549,989
1911	44	263,062	2,199,147	29,606	.....	2,214,838
1912	44	270,148	2,081,958	37,122	.....	2,104,788
1913	35	276,306	2,918,733	43,944	.....	2,945,275
1914	38	278,272	3,301,948	48,487	.....	3,328,761
Increase (+) in 1914	+3	+1,966	+383,215	+4,543	.....	+383,486

Nevada County made a splendid record in 1914, an increase being shown in number of producing mines and in production of ore, gold, and silver, and it made the highest output in gold among the counties of the State. The value of the gold was $3,301,948, or $219,946 more than Amador County, which ranks second in this respect. The production of gold from deep mines increased $157,096 and that from placers increased $226,116, a total increase of $383,215.

The quantity of ore treated in 1914 in the county was 278,272 short tons. There were 38 productive mines, of which 27 were deep gold mines and 11 were placers. The 3 drift mines yielded $44,326 in gold, the 3 hydraulic mines yielded $87,078, and the 5 surface placers $112,590, a total yield of $243,994 in gold from the placers. The deep mines produced 147,928.53 fine ounces of gold, valued at $3,057,954, and 47,429 fine ounces of silver, valued at $26,228, a total value of $3,084,182.

There were 274,930 tons of siliceous ore treated at the gold and silver mills, and 6 tons of siliceous ore were sent to the smelter in 1914. The value of the gold in mill bullion was $2,805,162, or $10.20 a ton, and the silver output from the same source was 37,414 fine ounces, valued at $20,690, or $0.08 a ton. The total value of the gold and silver recovered in the mill bullion was $2,825,852, an average value per ton of $10.28. From the milling ore there was obtained 3,826 tons of concentrates, which carried $216,552 in gold, or an average of $56.60 a ton, and 9,516 fine ounces of silver, valued at $5,262, or an average of $1.38 a ton. The total value of the concentrates was $221,814 in gold and silver, or an average value per ton of $57.98. From the 274,930 tons of milling ore there was recovered from both bullion and concentrates $3,021,714 in gold, or an average value of $10.99 a ton, and 46,930 fine ounces of silver, valued at $25,952, or an average of $0.09 a ton. The total value of the gold and silver recovered from bullion and concentrates was $3,047,666, the average value per ton being $11.08 in gold and silver. In addition there were 3,336 tons of old tailings treated, which yielded $35,889 in gold, an average of $10.76 a ton, and 405 fine ounces of silver, valued at $224, or $0.07 a ton, a total production of gold and silver from old tailings of $36,113, or an average value per ton of $10.83.

The principal quartz-mining district of Nevada County is that of Grass Valley, which includes the mines in both Grass Valley and Nevada City.

The following table shows the production of the Grass Valley district, 1904–1914:

Value of production of Grass Valley and Nevada City quartz mines, Nevada County, Cal., 1904–1914.

Year.	Grass Valley mines.			Nevada City mines.			Total.
	Gold.	Silver.	Total.	Gold.	Silver.	Total.	
1904	$1,738,979	$6,317	$1,745,296	$683,552	$3,400	$686,952	$2,433,248
1905	2,041,447	10,843	2,052,290	440,236	12,531	452,767	2,505,057
1906	2,196,990	16,516	2,213,506	133,031	5,755	138,786	2,352,292
1907	1,744,752	11,200	1,755,952	219,514	5,379	224,893	1,980,845
1908	1,869,176	11,953	1,881,129	192,037	8,552	200,589	2,081,718
1909	2,005,574	16,540	2,022,114	171,604	1,971	173,575	2,195,689
1910	2,113,499	13,101	2,126,600	118,688	1,731	120,419	2,247,019
1911	1,817,091	11,795	1,828,886	174,749	2,329	177,078	2,005,964
1912	1,779,401	18,168	1,797,569	75,890	2,109	78,059	1,875,628
1913	2,591,052	18,308	2,609,360	239,609	7,774	247,383	2,856,743
1914	2,658,355	19,179	2,677,534	339,050	6,689	345,739	3,023,273
Increase (+) or decrease (−) 1913	+67,303	+871	+68,174	+99,441	−1,085	+98,356	+166,530

Both Grass Valley and Nevada City increased the value of their output for 1914—Grass Valley by $68,174 and Nevada City by $98,356. The increase in yield of the entire district amounted to $166,530. The total ore treated in the district was 267,618 tons, of which 211,884 tons came from Grass Valley mines and 55,734 tons from Nevada City mines. The Grass Valley quartz mines produced 76 per cent of the ore of the whole county and the mines at Nevada City 20 per cent. The Grass Valley district, therefore, produced 96 per cent of the ores milled in Nevada County in 1914. The Grass valley deep mines produced $2,658,355 in gold and $19,179 in silver, or

about 87 per cent of the quartz gold obtained in Nevada County in 1914, and 73 per cent of the quartz silver, or 86.8 per cent of the total value derived from quartz ores. Nevada City deep mines produced $339,050 in gold and $6,689 in silver, or about 11 per cent of the quartz gold obtained in Nevada County, and 25.50 per cent of the quartz silver, or 11.2 per cent of the total value derived from quartz ores of the county during 1914.

The Grass Valley district (including Grass Valley and Nevada City mines) produced 98 per cent of the quartz gold, 98.6 per cent of the quartz silver, and 98 per cent of the total value derived from deep-mining operations in Nevada County in 1914. The producing mining companies at Grass Valley in 1914 were the Brunswick Consolidated, Central Consolidated, Empire Mines & Pennsylvania Shaft, Golden Gate Consolidated, Golden Center, Idaho-Maryland, North Star, Sunflower, and a few small properties. The Brunswick Consolidated is developed by a vertical shaft 1,100 feet deep and an incline shaft 1,250 feet deep. In 1914 the vertical shaft was sunk 240 feet and about 2,500 feet of drifting and crosscutting was done. The mine is equipped with a 20-stamp amalgamation and concentration mill. The 16,237 tons of ore treated yielded an average value of $17.76 a ton. The milling costs were $0.926 a ton and the mining costs $6.053 a ton. The percentage of extraction from the ore was 93.9 per cent. This mine has produced from 1893 to 1914, inclusive, $1,162,768. There have been 42 assessments levied, aggregating $1.22 a share, and the dividends have been $132,163. Contemplated construction work for 1915 includes a new head frame for the vertical shaft, a new mill or an addition to the present one, an assay office, and a small cyanide plant. The Empire Mines & Pennsylvania Shaft has 2 mills, 1 of 20 and 1 of 40 stamps, and one 160-ton and one 80-ton cyanide plant. The total length of incline shafts, drifts, and crosscuts is 11,921 feet. The mines were operated during the entire year 1914. The Golden Center opened the old Dromedary shaft, that has been closed since 1873. Since August, 1913, the shaft has been deepened 395 feet and 2,267 feet of drifts and shaft have been extended. The total depth of the incline shaft is now 696 feet. The mine is equipped with a 10-stamp mill and 4 concentrators. The Idaho-Maryland, after making some production, ceased operations in December, 1914. The North Star Mines Co., the most productive deep gold mine in the State, has an incline shaft, which was deepened during 1914 to 6,350 feet on the dip of the vein. In 1914 the gross value of the production of the North Star mine was $1,115,586.97, obtained at a cost for current operation of $527,875.62 and for development of $54,462.24, or a total outlay for operation and development of $582,337.86. Dividends amounting to $450,000, or 18 per cent on the capital stock, were paid during the year.

The ore was derived chiefly from stopes above the 3,400-foot, 4,000-foot, and 4,400-foot levels, and the value was obtained from 113,502 tons of rock mined and delivered to the mills. From this total of ore 6,252 tons was sorted out as waste, leaving 107,250 tons of ore to be crushed, which yielded an average value per ton of $10.40 at an average cost per ton of $4.92 for operating expenses and of $0.51 for development expenses—an aggregate cost per ton crushed of $5.43 (per ton mined, $5.14) and a realized profit per ton crushed of $4.97.

The value per ton in 1914 was 91 cents less than in 1913, partly because of the fact that in 1913 a considerable amount of accumulated gold was recovered from the tube mill, which tended to increase the value per ton. The cost of operation and development per ton in 1914 was $5.43, as compared with $5.20 in 1913. This increase in 1914 was due, in part, to a smaller production of ore from development work and, in part, to certain extraordinary outlays for repairs at the North Star mill and for retracking the vertical and inclined shafts, which outlays were charged to operating expenses.

Of the total metallic production for the year, 79.04 per cent was obtained in the mills by amalgamation, and 20.96 per cent was recovered by cyanidation. The assay value of the tailings from the cyanide plants was 30½ cents a ton, indicating a total loss in treatment of $32,500, or a little less than 3 per cent of the total contained value of the ore.

Development work in the North Star mine consisted, chiefly, in the extension of drifts and raises on or connected with the 3,000-foot and 3,400-foot west levels and in the sinking of the shaft from 5,850 to 6,361 feet and the cutting of stations at 5,600, 6,000, and 6,300 feet. The work in the upper levels resulted in the discovery of some good ore on and above the 3,400-foot level, warranting the expectation of a considerable body of ore in this part of the mine not previously counted on. The shaft disclosed, for the most part, a large but barren vein. It is hoped that the levels now started at 5,600, 6,000, and 6,300 feet will reveal the downward extension of the profitable ore bodies found on the 5,000-foot and 5,300-foot levels. The total development work accomplished amounted to 2,053 feet (shaft sinking, 511 feet, drifting, 954 feet, and raising, 588 feet). In cutting the stations, a total of 5,183 tons of waste rock, equivalent to about 57,000 cubic feet of material, was removed and hoisted to the surface. Owing to the nature of the exploration work, a comparatively small quantity of development ore was produced during the year, the total being 2,117 tons as compared with 6,420 tons in 1913. The additional ore developed or indicated on and above the 3,400-foot level will offset to a large extent the tonnage mined during the year; and the mine is in about its usual condition of having an ore supply, developed or indicated, of about the average quality, calculated to last for several years to come.

In Nevada City work was started at the Bellefontaine in April, 1914, and shortly thereafter a small mill with concentrator was completed. The Champion, now the property of the North Star Mines Co., is the only large producer at Nevada City. Development work was actively continued throughout the year on both the Champion and Merrifield veins to the extent of 4,047 feet of drifts and raises, with the promise after further development, principally on the Champion vein, of a considerable body of fair ore. The workings are spread out over a wide area and it is difficult at present to operate the property to the best advantage. The results obtained during the latter half of the year, however, seem to give promise for the future, and it has therefore been decided, with a view to the more economical opening and working of the mines, to enlarge and extend the Providence shaft, situated some distance south of the Champion shaft, through which work is at present being conducted. During the year 45,050 tons of ore were crushed at the Champion, yielding

$301,102, or $6.68 a ton. The outlay of the North Star Mines Co. on the Champion has thus far been $1,165,716, and the production $455,631.

The Croesus made only a nominal output, and what was taken from the Grizzly Ridge was by lessees. The Pittsburg did considerable development work in 1914, and kept 10 of the 20 stamps of its mill dropping. The Zeibright is opened by a tunnel 1,450 feet long. The mine was run continuously in 1914, and the ore was crushed in the 10-stamp mill.

The Birchville, Little Bear Creek, and Republic mines were producers at Graniteville, and there was some yield from the Black Bear group at Moores Flat. The Consolidated St. Gothard, at North Columbia, was worked for only three months of the year. The producers at Washington were the Erie Consolidated, Gaston, and Ocean Star. The Gaston was worked only a portion of the year. During the year water was installed as motive power, displacing electricity. The mine is opened by a tunnel 4,875 feet in length. The Ocean Star was operated about five months in 1914.

None of the placers in Nevada County are now large producers, the restrictions as to hydraulic mining having long since closed down the more productive ones. Mainly drift and sluice mining are now being carried on, but there is some hydraulicking. The productive placer mines of the county are the Liberty Hill, not far from Dutch Flat; Fisher, at French Corral; Remington Hill, at Lowell Hill; Birdseye Creek, Nevada, and You Bet mines, in You Bet district, 6 miles from Dutch Flat; and Omega, near Washington. A great deal of placer gold from different portions of the county is yearly brought into Grass Valley and Nevada City for sale by prospectors and miners who are lessees or workers of small properties during the winter season.

There are a number of nonproductive mines in the county on which development work was carried on during 1914.

PLACER COUNTY.

In 1914 Placer County produced gold and silver valued at $601,855, as compared with $223,757 in 1913, an increase of $378,098. The increase in output of gold in 1914 was $376,427. The total yield of gold was 28,890.13 fine ounces, valued at $597,212, and the yield of silver was 8,396 ounces, valued at $4,643. The deep mines produced from 36,851 tons of ore, 6,521.53 fine ounces of gold, valued at $134,812; 5,828 ounces of silver, valued at $3,223; 496 pounds of copper, valued at $66; and 615 pounds of lead, valued at $24. The total value recovered from the deep mines was $138,125. The placer-mine yield was 22,368.60 fine ounces of gold, valued at $462,400, and 2,568 ounces of silver, valued at $1,420. Of the placer gold $12,004 was derived from hydraulic mines, $296,012 from 3 dredges, $132,709 from 23 drift mines, and $21,675 from 9 surface placers. The placer-mine yield was $325,386 more in 1914 than in 1913. The deep-mine increase in gold was $51,041. There were 36 producing placers in the county in 1914, or 10 more than in 1913, and there were 6 productive deep mines, a total of 42. Placer continues to be the leading drift-mining county of the State. The most material increase in gold came from the dredges, this increase being $217,173 for the year, but the drift-mine output also increased $87,883.

Of the deep mines in the county the Oro Fino and Jubilee, near Auburn, were only nominal producers, as was the Yellow Metal, at Forest Hill. The Vantrent Mining Co., near Lincoln, made the largest output of the deep mines in the county. The Major, at Newcastle, produced a little copper, lead, and gold. The Helester, at Towle, is a good gold producer. The Pioneer, at the same place, was operated for six months. The mine is opened by two crosscut tunnels, 2,640 and 1,680 feet long, respectively. In 1914 drifts of 425 feet were run on ore. The mine is equipped with a 20-stamp mill and a 3-ton cyanide plant for concentrates.

Three dredge companies operated in Placer County in 1914. The Gaylord Mining Co. is dredging on bars in American River, near Auburn; the El Dorado & Placer Counties Co. began dredging on the Middle Fork of American River in March, 1914; and the Pacific Gold Dredge Co. began work in 1914 on the Middle Fork of American River above Auburn. Most of the other placer producers of the county are drift mines, of which the principal are the Haub, at Blue Canyon; Christmas Hill and Red Hill, at Butchers Ranch; Federal Drift Mining Co., operating through lessees the Rough and Ready claim, at Dutch Flat; Union Placer, at Dutch Flat; Chinese lessees operating the Omega mine of the South Yuba Mining & Development Co., at Emigrant Gap; Gavin, Dardanelles, Mayflower, and Paragon, at Forest Hill; Indian Hill, at Gold Run; Gleason Consolidated, McGeachin, Penn Valley, and Sparahawk, at Iowa Hill; Frankmont and Pacific Slab Consolidated, at Last Chance; Barton, Parmenter, and Pendleton, at Loomis; and Big Gun, Bigelow, Devil's Gate, and Sierra Nevada, at Michigan Bluff. Some of these claims are worked by lessees only.

The Hidden Treasure, at one time a large producer among the drift mines, was not operated in 1914, but has since been started up. At the Auburn, Forest Hill, a 650-foot bedrock tunnel is being cut to tap the channel. The Eureka Consolidated Drift Co., at Forest Hill, is still hunting for the channel. The Beaver Gold Dredge Co., at Loomis, sold its property to the El Dorado & Placer Counties Co. and went out of business.

PLUMAS COUNTY.

Number of mines producing in Plumas County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, copper, and lead produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	
1905	88	31,455	$269,992	1,847	1,066	.....	$271,274
1906	78	21,040	229,350	1,575	.....	.....	230,405
1907	80	23,907	219,355	1,436	.....	.....	220,303
1908	51	29,537	254,737	6,717	.....	.....	258,297
1909	54	27,795	157,491	1,130	.....	.....	158,078
1910	46	41,681	187,207	1,923	.....	1,114	188,294
1911	53	47,470	228,785	2,123	1,328	.....	230,076
1912	67	27,398	193,237	1,556	16,381	5,837	197,160
1913	39	35,354	138,368	1,167	22,677	5,432	142,827
1914	32	20,036	136,237	5,718	339,744	.....	184,585
Increase (+) or decrease (−) in 1914	−7	−15,318	−2,131	+4,551	+317,067	−5,432	+41,758

The total yield from the mines in Plumas County in 1914 was $41,758 more than in 1913. This was almost entirely owing to the value of the copper, although there was some increase in silver also. The quantity of ore treated fell off materially, and there was a small decrease in the gold.

The production of gold from deep mines was 3,077.13 fine ounces, valued at $63,610; the production of silver was 5,365 ounces, valued at $2,967; and the copper was 339,744 pounds, valued at $45,186. There were 18,838 tons of siliceous ore treated at the mills, which yielded $63,040 in gold and 365 fine ounces of silver, valued at $202. The crude ore treated at gold and silver mills yielded no concentrates. The placer mines produced 3,513.33 fine ounces of gold, valued at $72,627, and 353 fine ounces of silver, valued at $195. There were 23 producing placers and 9 producing deep mines. Of the placers, 4 hydraulic mines produced $32,077 in gold, 4 drift mines produced $12,956 in gold, and 15 sluicing mines produced $27,594 in gold. There was a decrease of 3 hydraulic mines and 3 drift mines and an increase of 3 sluicing mines in 1914, as compared with 1913. There was an increase in the production from hydraulic and sluicing mines and a continued decrease in the output from drift mines.

Of the Plumas County deep mines, the Jamison, at Johnsville, was the most productive. It is opened by a crosscut tunnel of 3,764 feet, a drain tunnel of 1,800 feet, and a 150-foot vertical shaft. Owing to a better water season the mine and mill, the machinery of which is operated by water power, were enabled to run 8½ months in 1914, as against 7 months in 1913. The mine is equipped with a 20-stamp mill. The second in rank of production among the deep mines of the county was the Engels Copper Mining Co., near Taylorsville, which appears for the first time among the productive properties. This company built a smelter at its mine, but external difficulties prevented its use, so that the ores were shipped in 1914 to the Garfield smelter, Utah. The mine was operated from May 15 to the end of December. During the latter part of the year a 250-ton oil flotation concentration mill was completed and has since been utilized. Among other deep-mine producers are the Bullion, at Clio; Plumas Amalgamated, at Crescent Mills; Gruss, at Genesee; Arcadia, at Greenville; Crown Point and Oro Fino, at Quincy; and Seneca Consolidated, at Seneca.

The producing placer mines are the Indian Hill, at Belden; Geogle, at Clio; Golden Key, at Crescent Mills; Pactolian, at Genessee; Bellevue drift and Consolidated Placer, at La Porte; Soda Ravine, at Longville; Gold Mountain Hydraulic & Dredging Co., New York, and Old Rutherford, at Meadow Valley; Castle Rock, Willow Creek, and Spring Garden, at Quincy; Scott, at Seneca; Ruffa, at Taylorsville; and Indian, at Twain.

Of the nonproductive mines the Genessee Valley Copper Co. continued development work, as did also the Walker Copper Co. at the same place. The Plumas Investment Co. confined its work during the year at Meadow Valley to ditch construction. Since the close of the year 1914 the famous old Plumas-Eureka mine in this county, which is supposed to have produced about $12,000,000, is being reopened by a tunnel intended to develop the property to a lower depth. The main tunnel has also been cleaned out and repaired.

SACRAMENTO COUNTY.

Number of mines producing in Sacramento County, Cal., quantity of ore sold or treated, 1905–1914, total gold and silver produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Total value.
		Short tons.		*Fine ounces.*	
1905	8	.....	$650,624	2,745	$652,228
1906	8	.....	986,624	5,433	990,264
1907	12	.....	790,973	3,082	793,007
1908	20	.....	1,166,055	3,058	1,167,676
1909	12	.....	1,669,814	5,492	1,672,670
1910	17	150	1,396,874	8,530	1,401,480
1911	11	.....	1,812,826	5,749	1,815,873
1912	15	.....	1,712,587	5,762	1,716,131
1913	15	.....	2,503,633	5,639	2,507,039
1914	12	.....	2,164,491	6,295	2,167,972
Increase (+) or decrease (−) in 1914	−3	.....	−339,142	+656	−339,067

Sacramento County is fourth in rank in the four counties of California which produced more than $2,000,000 in gold in 1914. The total output of gold was $2,164,491 in 1914, which is $339,142 less than in 1913. The output of silver increased by 656 ounces. The total value of the production of gold and silver was $2,167,972, which is $339,067 less than in 1913. The entire gold of the county was produced from placers, no deep mines being operated. In 1913 Sacramento was the leading county in the production of placer gold, but in 1914 it took second rank, Yuba exceeding it by $634,365. The gold of Sacramento County is produced almost entirely by dredging operations in the vicinity of Folsom. Eleven dredges were operated in the Folsom field in 1914, as compared with 12 in 1913, 11 in 1912, and with 10 in 1911. The Ashburton dredge of the New England Exploration Co. did not operate in 1914, the dredge being dismantled and sold, as the property was worked out in November, 1913. The Natomas Consolidated of California operated 9 dredges for 12 months and 1 dredge for 10 months. The Wilkesbarre Dredging Co. succeeded the Old Union Dredging Co. in 1914, and the single dredge of the company was operated by the Natomas Consolidated after November 10, 1914. The Embach, Willow Spring Hill, and Wright & Donnelly drift mines were all idle. In 1914 the Natomas Consolidated recovered platinum valued at $7,000 from its gold-dredging operations in the Folsom field.

The following table shows the dredge-gold output from the Folsom field for several years, with the annual increase or decrease, and the total:

Mine production of gold of Folsom dredging district, California, 1902–1914, with increase (+) or decrease (−), by years.

Year.	Production.	Increase (+) or decrease (−).	Year.	Production.	Increase (+) or decrease (−).
1902	$155,194	.....	1910	$1,369,594	−$164,542
1903	102,097	−$53,097	1911	1,805,071	+ 435,477
1904	348,990	+246,893	1912	1,672,797	− 132,272
1905	569,124	+220,134	1913	2,498,603	+ 825,806
1906	921,300	+352,176	1914	2,161,653	− 336,950
1907	649,511	−271,789			
1908	1,109,196	+459,685	Total	14,897,266	.....
1909	1,534,136	+424,940			

SAN BERNARDINO COUNTY.

Number of mines producing in San Bernardino County, Cal., quantity of ore sold or treated, 1905–1914, and total gold, silver, copper, lead, and zinc produced.

Year.	Number of mines producing.	Ore.	Gold	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	15	34,039	$434,461	66,969	52,603	.....	.....	$483,116
1906	15	37,271	354,830	50,396	514,031	30,700	.....	489,552
1907	27	26,158	158,676	123,241	590,649	9,020	.....	358,623
1908	49	25,182	180,511	67,366	201,993	117,024	.....	247,793
1909	35	4,449	40,071	24,173	148,312	11,366	.....	72,410
1910	25	7,102	55,093	18,822	5,992	1,545	.....	66,086
1911	55	18,190	127,367	67,061	679,984	23,466	182,316	259,355
1912	29	44,722	293,900	81,238	1,890,008	96,439	.....	660,053
1913	54	40,513	356,524	73,531	484,568	237,480	.....	486,494
1914	25	32,037	209,472	67,737	89,820	39,513	.....	260,418
Decrease in 1914..	29	8,476	147,052	5,794	394,748	197,967	.....	226,076

A general falling off in quantity and value of metals produced in San Bernardino County in 1914 as compared with 1913 is apparent from the table above, the total decrease in value being $226,076. The greatest decrease in value was in gold and amounted to $147,052. Only 25 producing mines reported in 1914, a decrease of 29 from 1913. There was not much decrease in silver, but there were 394,748 pounds less of copper and 197,967 pounds less of lead produced in 1914 than in 1913.

The silver produced in the county in 1914 was valued at $37,459, the copper at $11,946, and the lead at $1,541. Ten gold mines, 7 copper mines, 4 silver mines, 2 lead mines, 1 silver-lead mine, and 1 placer reported production in 1914. There were 31,378 tons of siliceous ore sold or treated in the county, 233 tons of copper ore, 53 tons of lead ore, 67 tons of silver-lead ore, and 306 tons of silver ore, a total of 32,037 tons. Of this total quantity, 28,021 tons were treated at gold and silver mills and yielded $188,620 in gold, and 10,720 fine ounces of silver, valued at $5,928. No concentrates were produced from this ore. There were 766 tons of crude ore sent to smelters that yielded $10,004 in gold and 56,649 fine ounces of silver, valued at $31,327. In addition, 3,250 tons of old tailings were treated, which yielded $10,128 in gold and 363 fine ounces of silver, valued at $201. The copper ores produced 226.39 fine ounces of gold and 680 fine ounces of silver. The lead ores produced 9 fine ounces of gold and 821 fine ounces of silver. The silver ores yielded 14.17 fine ounces of gold and 44,904 fine ounces of silver, and the silver-lead ores, 1.02 fine ounces of gold and 9,486 fine ounces of silver.

The most important productive mine in the county in 1914 was that of the United Greenwater Copper Co., at Dale, which is opened by a shaft 1,100 feet deep. Very active development work was carried on during the year, 6,900 feet of drifts, raises, and crosscuts having been made. The ore was all obtained from the Supply mine and was worked by dry crushing and direct cyanidation in the 75-ton cyanide plant. This ore is siliceous and oxidized to lowest level. The output was mainly in gold, with some silver, but no copper. In 1913 the most productive mine was that of

the Pacific Mines Corporation, at Ludlow, but no ore was extracted from it in 1914. The Badgad-Chase Co., at Barstow, obtained considerable gold by the treatment of old tailings by cyanidation. The Barstow Reduction Co., at Barstow, reported returns in silver ore only. The J. Z. Barnett Mining Co., at Barnwell, was only operated a few months and shipped its ore for treatment to the Salt Lake smelters. The Jacknife Group, at Vidal, produced mainly copper, with some gold. The Death Valley Arcalvada Consolidated Mines Co. shipped its silver ore to Salt Lake to be smelted, there being no reduction plant at the mine. The New Era, at Cima, produced a small quantity of lead ore. The Lucy Gray, at Desert, produced some gold and copper. The Pilot, at Goffs, shipped copper-gold ore to the smelters at Salt Lake City; the mine was only worked part of the year. Some lead ore was shipped from the Carbonate mine, at Halleck; some silver-lead ore from the Maricopa Queen, at Milligan; and some gold ore from the Hidden Hill, at Needles. At Silver Lake the small producers are the Riggs Mining Co., Brauer & Sons, and Cameo. Silver ore only was produced by the Silver Belt mine at Trona. The Gold Mountain mine, at Victorville, is opened by an adit 800 feet long, but the work in 1914 was by open-cut mining. The property is equipped with a 40-stamp amalgamation mill, and, during 1914, a 100-ton cyanide plant was installed, but not operated. The Arnold, at Vidal, produced some copper and gold in 1914; and McKesson & Dunne, at the same place, mined a few tons of gold-bearing ore. A nominal output of gold came from a surface placer at Barstow. A large number of properties in this county reported only assessment work done during 1914.

SHASTA COUNTY.

Number of mines producing in Shasta County, Cal., quantity of ore sold or treated, 1905–1914, and total gold, silver, copper, lead, and zinc.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	38	214,036	$706,738	270,530	10,830,865	.....	.....	$2,559,753
1906	30	327,482	819,144	648,482	22,477,304	.....	.....	5,591,748
1907	35	342,856	791,997	560,926	25,457,417	.....	.....	5,853,691
1908	39	556,922	1,131,832	976,596	33,852,842	.....	.....	6,118,003
1909	34	854,256	1,600,489	1,414,346	50,013,511	.....	.....	8,837,706
1910	46	696,333	1,533,728	1,201,676	40,397,284	196	.....	7,313,097
1911	63	520,795	1,133,476	730,171	29,618,032	.....	.....	5,222,988
1912	39	415,116	928,243	691,257	24,618,550	.....	.....	5,415,426
1913	41	477,746	1,208,870	741,773	27,044,297	19,295	93,914	5,854,875
1914	31	436,211	1,101,202	626,954	25,198,669	.....	.....	4,799,331
Decrease in 1914	−10	−41,355	−107,668	−114,819	−1,845,628	−19,295	−93,914	−1,055,544

Shasta County has held for some years the position of the leading county of California in metallic output, mainly by reason of its superiority in the copper-mining industry. In 1914 the total value of the metals produced in the county was $4,799,331, a decrease of $1,055,544 as compared with 1913. There were 10 less mines operated productively in 1914 than in 1913; 41,535 fewer tons of ore were treated; the yield of gold was $107,668 less; the silver

decreased by 114,819 ounces, the copper by 1,845,628 pounds, the lead by 19,295 pounds, and the zinc by 93,914 pounds. There was only one copper smelter in operation in the county in 1914, although a great deal of ore was shipped to smelters at Martinez, Cal., Mason Valley, Nev., and Salt Lake City, Utah. The smelter-fume litigation is responsible for the reduction in number of the operating smelting plants in the county.

The total number of deep mines from which production was reported was 22, as against 32 in 1913. Of these, 18 were gold mines and 4 were copper mines. The output of 436,211 tons of ore was made up of 84,220 tons of siliceous ore and 351,991 tons of copper ore.

The placer mines of the county in 1914 yielded 6,213.77 fine ounces of gold, valued at $128,450. This production came from 3 dredges and 6 surface placers.

The gold from the deep mines amounted to 47,056.88 fine ounces, valued at $972,752, and the silver to 625,947 fine ounces, valued at $346,149. The gold derived from siliceous ore amounted to 33,938.64 fine ounces, valued at $701,574, and that from copper ore to 13,118.24 fine ounces, valued at $271,178. The production of silver from siliceous ore was 33,220 fine ounces, valued at $18,371, and from copper ore 592,727 ounces, valued at $327,778. The siliceous ore therefore yielded $719,945 in gold and silver and the copper ore yielded $598,956 in gold and silver, a total of $1,318,901 in gold and silver from the deep mines.

The gold and silver mills in Shasta County in 1914 treated 49,205 tons of ore, which yielded in gold bullion $265,356, an average of $5.39 a ton, and 2,031 fine ounces of silver, valued at $1,123, an average of $0.02 a ton. The total recovery of mill bullion was valued at $266,479, or an average value in gold and silver of $5.41 a ton. This ore produced 1,743 tons of concentrates, with a gold value of $78,668, and 533 fine ounces of silver, valued at $295, a total value of concentrates of $78,963. The average value per ton of the concentrates was $45.13 in gold and $0.17 in silver, a total average per ton of $45.30. The total gold value of the ore treated at gold and silver mills was $344,024, an average of $6.99 a ton; the silver value was $1,418, or $0.03 a ton; and the total gold and silver value from mill bullion and from concentrates was $345,442, or an average recovery of $7.02 a ton.

The crude ore sent to the smelters, amounting to 385,589 tons, produced (in addition to the copper), $626,056 in gold, an average of $1.62 a ton, and 623,289 fine ounces of silver, valued at $344,679, or $0.90 a ton. The total value of gold and silver recovered from ore sent to smelters was $970,735, or an average value of $2.52 a ton.

There were treated in the county 1,417 tons of old tailings in 1914, which yielded $2,672 in gold and 94 fine ounces of silver, valued at $52, or a total value of $2,724.

All the smelting plants in Shasta County were idle in 1914, except the plant of the Mammoth Copper Co., at Kennett, which operated three 400-ton furnaces for seven months, and two 400-ton furnaces for five months. The property (the largest producer in the State) was in continuous operation during 1914, but with a reduced output after August. The process in use is straight pyritic smelting to matte and conversion of matte to blister copper. The blister copper is

shipped to the U. S. Metals Refining Co., at Chrome, N. J. The ore treated is a copper sulphide. The Balaklala Consolidated Copper Co. operated on a small basis in 1914 until September, when its 2,000-ton smelter was closed by decree of the courts owing to smelter-fume litigation. Considerable ore was mined from the old stopes and shipped for reduction to the Mammoth Copper Co., and also to the Mason Valley smelter, in Nevada. The Mountain Copper Co. (Ltd.), another of the larger producers of the county, near Keswick, operates three mines, the Iron Mountain, the No. 8, and the Hornet. There is no reduction plant at the mine, but the ore is transported by rail to a smelting plant near Martinez, on San Francisco Bay (about 250 miles). The sulphide ore is roasted to manufacture sulphuric acid, and then the calcines, with suitable mixture of other ores, are smelted in reverberatory furnaces. The copper matte, carrying the gold and silver, is converted to blister copper, which is shipped to the Baltimore Copper Smelting & Rolling Co., Baltimore, Md. The smelter of the Mountain Copper Co. was only in operation in 1914 until August, when it was closed down on account of the European war. At this property some copper cement is produced from the mine water by precipitation on scrap iron. At Bayles the only producer of note is the Original Quartz Hill, under lease to the Mammoth Copper Co., of Kennett. The Ruby Pearl, at Castella, made a small output. At French Gulch the producers were the American, Denver Lode, El Dorado & Eureka group, Hazel, Mount Bully, Summit Gulch, Washington, and Western Exploitation Co. Of these the Hazel Gold Mining Co., operating the Gladstone mine, is the most important. This property is opened by an adit 3,600 feet long and an underground vertical shaft 1,250 feet deep. Some shaft sinking was done in 1914. The property is equipped with a 30-stamp mill and Wilfley and Frue vanners. The Virginia was a small producer at Kennett, and has a 10-stamp mill and vanners. The Victor Power & Mining Co., at Knob, in Harrison Gulch district, was one of the larger gold producers in the county in 1914. Some output came from the Mariana Marsicano and the Graves mines at Ono. Operators of the Shasta Monarch, at Shasta, with a 5-stamp mill as crushing equipment, installed a new air compressor in 1914 and did some development work. The Evening Star, at Whitehouse, supplied gold ore to the Mammoth smelter for reduction, as did the Bully Cave, at Winthrop. A number of small properties in different portions of the county supplied ores to the Mammoth smelter during 1914, the aggregate value in gold, silver, and copper amounting to $191,750.

Of the placer mines of Shasta County, there was some output at Bayles, French Gulch, Gas Point, Redding, and Stella. Three dredges also made some production in the county in 1914, the Shasta Dredging Co., at Larkin; the Shasta Mining & Dredging Co., near Redding; and the U. S. Gold Dredge Co., at Redding.

SIERRA COUNTY.

The total metal production for Sierra County in 1914 was valued at $725,129, as compared with $1,011,136 in 1913, a decrease of $286,007. Of this decrease, $284,410 was in gold, $1,339 in silver, $75 in copper, and $183 in lead. There were 65,411 tons of siliceous ore treated in 1914, yielding 29,201.33 fine ounces of gold, valued at

$603,645, and 4,732 ounces of silver, valued at $2,617, making a total value of $606,262 from the deep mines. The output from the placers of the county in 1914 was 5,733.31 fine ounces of gold, valued at $118,518, and 631 ounces of silver, valued at $349, a total of $118,867. Of this placer gold $83,217 came from hydraulic mines, $31,931 from drift mines, and $3,370 from surface or sluicing mines. There were 38 producing mines in the county in 1914, of which 14 were deep gold mines. Of the 24 placers, 6 were hydraulic, 10 drift, and 8 surface mines. The deep mines in 1914 produced $485,127 more gold than the placers, notwithstanding that the deep mine output of gold was decreased by $327,280 in 1914, as compared with 1913.

At Alleghany, the principal producing center of the county, the deep mines in 1914 produced in gold $433,917 from 45,809 tons of ore, as compared with $668,037 from 41,641 tons of ore in 1913. Although the ore of 1914 increased by 4,168 tons, the yield in gold was $234,120 less than in 1913, indicating a material falling off in average value per ton of the ore milled. At this place the Croesus is opened by 4 tunnels, connected by raises, with a winze from the lower tunnel and three levels from it. The mine and mill were operated the entire year. The Original 16 to 1 mine is opened by a 1,200-foot adit and an incline shaft to the 300-foot level. The Tightener Mines Co., owning the most productive mine in the district, has a 20-stamp mill and ships its concentrates to the smelter. The Gold Canyon Mines Co. is opened by an incline shaft 400 feet deep and has upward of 3,000 feet of drifts. There is a 5-stamp mill with 2 Frue vanners on the property. Near Downieville, the Round Lake and the Sierra & El Oro companies are the deep-mine producers. A small output came from the Kate Hardy, at Forest. The Four Hills, at Johnsville, was operated by lessees, only the higher grade ore being milled. The Sierra-Alaska, at Pike, a large producer, is opened by a 680-foot vertical shaft and a 775-foot adit, with a winze. The total depth in the mine is 915 feet. About 3,655 feet of development work was accomplished during 1914. The mill has 40 stamps, with concentrators, and a small cyanide plant was added in 1914. The low-grade concentrates were stacked to await treatment. The mill, having a greater capacity than required, was rarely run at full capacity. The deep-mine producers at Sierra City, are the Cleveland, Grandma and Kentucky, Essex, and Sierra, Buttes. The Sierra Buttes has a 20-stamp mill and a 100-ton cyanide plant. Since the close of 1914 the "lost ledge," for which prospectors have been looking for several years, has been found. The mine has been for many years a steady and large producer.

Of the placer mines of the county, the Brandy City hydraulic is operated between North Yuba River and Canyon Creek. The producers at Camptonville are the Depot Hill hydraulic, the Indian Hill hydraulic, and the Indian River drift mines. At Downieville are the Best Chance sluicing mine, Good Cause drift, Monte Cristo drift, and a few other mines. At Forest are the Bull Moose drift and the Secret Canyon sluice mines. At Pike, the Bope Mining Co. worked bench gravel and tailings, and the Confidence Mining Co. drifted on the claims on the Mountain House ridge. At Scales, the Neocene Placer Mining Co. made a small output by hydraulic work. In this section of the county considerable gold is taken out annually by

Chinese miners who lease claims. Small placers were worked at Sierra City, in the Big Canyon, and the Ladys Canyon. At St. Louis the Caledonia made a small output. At Table Rock are the Bruckerman and The Miners Home mines, the latter on the divide between Slate and Canyon creeks.

SISKIYOU COUNTY.

In 1914 Siskiyou County produced 15,133.73 fine ounces of gold, valued at $312,842, and 1,855 ounces of silver, valued at $1,026, a total of $313,868. This was an increase of $132,515 in 1914, as compared with 1913. There was 19 deep mines producing, as compared with 16 in 1913, an increase of 3, and they produced 10,543 tons of ore, yielding 2,192.23 fine ounces of gold, valued at $45,338, and 322 ounces of silver, valued at $178, a total of $45,516, as compared with $50,034 in 1913. The 48 producing placers yielded 12,940.50 fine ounces of gold, valued at $267,504, and 1,533 ounces of silver, valued at $848, a total of $268,352, as compared with $131,319 in 1913. This is an increase of $137,033 for 1914 as compared with 1913, of which $136,837 was gold, or more than 100 per cent. The placers thus yielded $222,836 more in gold and silver than the deep mines. The number of producing mines (67) in Siskiyou is larger than in any other county of the State, but there were 7 mines less than in 1913. Of the placers 39 hydraulic mines produced in gold $152,185, and the 7 drift and surface placers and the 2 dredges produced $115,319 in gold. The hydraulic mines produced $27,840 more in gold in 1914 than in 1913. There are no Federal restrictions on hydraulic mining in this county as in the counties in the drainage basins of Sacramento and San Joaquin rivers. The only producer of note among the deep mines at Callahan is the Trail Creek Mining Co., although the Bouvier, Eaton group, Pocket Dyke, Shasta Mining Co., and Two and a Half made some output also. At Black Bear there was a small production from the Monarch. The Highland Mining Co., at Etna Mills, operated its 2-stamp mill. At Gilta the Gold Run Mines Co. operated the Gold Run mine under lease and bond, making some output but discontinuing work before the end of the year. A small yield was made from the Little Bonsa pocket mine at Hawkinsville. The La Flesh was the largest deep-mine producer at Hornbrook; it has a 3-stamp mill. Other deep mines producing at this place were the Indian Girl, Moon pocket, and Negro Boy. At Rollin the deep-mine producers are the Eureka & W. Y. O. D. and Merriam & Goodale. Some old tailings were put through the mill at Fort Jones; and the Le May claim, at Yreka, made a nominal output.

Of the placers of the county the largest producer is the Siskiyou Dredge Co., at Fort Jones. At Black Bear the largest producer is the Michigan Salmon Mining Co., operating a hydraulic mine. Other producers there are the Beeson Brothers, Baines, Graham Gulch, Nugget Bar, Orcutt, and Wandell. The combined production of gold by the placers at this place in 1914 was $16,549. At Callahan are Beaudry's Wild Cat, Kangaroo, and Sugar Hill, all small hydraulic mines. The Banner and the Salmon River hydraulic mines are at Cecilville. There are a few hydraulic mines in operation at Forks of Salmon, at Fort Jones, and at Greenview. The Freshour Bar and

the Sulphur Springs mines were productive at Gottville. The Kunz Flat hydraulic is at Hamburg. The principal among the hydraulic producers at Happy Camp is the Siskiyou Mines Co., and others are the Additional, Davis Consolidated, Huey Hill, Morning Star, Pennsylvania, and Squirrel Creek, the combined gold production of which in 1914 was $45,908. The Siskiyou Klondike hydraulic mine is at Oak Bar, and the Frazier is at Rollin. The hydraulic mines at Sawyers Bar are the Forks of Salmon, Gold Hill, Klein, Thomain, and Burns, the combined output of which was $24,525. The Blue Hill and the Quartz Hill hydraulic mines are operating productively at Scott Bar, and so is the Jack Lowden mine at Seiad Valley. At Somes Bar are the Blue Nose, Ten Eyck, and Reynolds Creek hydraulic mines. The Jensen is a small hydraulic at Walker. At the mouth of Greenhorn Creek, 1 mile south of Yreka, the El Oro Dredging Co. operated its dredge 114 days in 1914. This is an Oroville company which started this dredge in Siskiyou County during the year. Of the nonproducing mines of the county, at the Lucky Strike at Etna Mills, prospecting has been done to find the permanent ledge in a broken up country. The Patterson Creek Mining Co. at Fort Jones, discontinued operations entirely in June, 1914. Development work was done the entire year on the Eliza group in Humbug Creek, near Yreka, but the 10-stamp mill was not started up. Development work was kept up on the Commodore, at Walker, with hope of production in 1915.

TRINITY COUNTY.

In 1914 Trinity County produced 35,967.40 fine ounces of gold, valued at $743,512, and 6,101 ounces of silver, valued at $3,374, a total of $746,886 and an increase of $312,905 in gold and silver in 1914, as compared with 1913. The increase in gold was $311,650. There were 57 mines which reported production in 1914. Of these, 15 were deep gold mines; and of the 42 placers, 30 were hydraulic, 2 dredges, 1 drift, and 9 surface. The deep mines produced from 27,720 tons of ore 11,322.56 fine ounces of gold, valued at $234,058, and 3,472 ounces of silver, valued at $1,920, a total of $235,978 in gold and silver, as compared with a total of $74,227 in 1913, an increase of $161,751. The ore treated in 1914 was 24,223 more tons than in 1913. The largest proportion of ore came from the Globe Consolidated mine at Dedrick. The 42 placers yielded 24,644.84 fine ounces of gold, valued at $509,454, and 2,629 ounces of silver, valued at $1,454, a total of $510,908, an increase of $151,154 for 1914, as compared with 1913. The hydraulic mines of the county increased their yield for the year by $197,048, but the dredge yield decreased by $36,907. There are no restrictions in this county on hydraulic mining. Trinity is the leading hydraulic mining county of the State.

With the exception of the Globe Consolidated Mining Co., at Dedrick, there are no specially large producers among the deep mines of the county. The total amount of workings in this mine exceed 10,000 feet. The mine is equipped with a 100-ton all sliming cyanide plant, and the cyanide product is shipped to the smelters. The Oro Grande is a producer at Carrville; Amy Bach, Brown Bear, and California-Michigan, at Deadwood; Oriole and Texas Jack, at Douglas

City; Enterprise and Yellowstone groups and Rattlesnake, at Helena; Blue Jay and Knob Pocket, Gold Hill group, and Last Chance, at Lewiston; Fairview, at Minersville; Quinby, at Quinby; and Five Pines and Surprise, at Trinity Center.

Among the placers the most productive properties are the La Grange hydraulic mine, at Weaverville; the Alta Bert dredge, at Trinity Center; and the Trinity Dredging Co., at Lewiston. At Big Bar, the Annie and Hall Flat, Canadian Bar, Cedar Flat, Fortune Teller, and Little French Bar hydraulic mines made a combined output of $4,662 in gold. The South Fork Gold & Platinum Co. was a small producer, as was the Little Klondike, at Blocksburg. The producers at Carrville, were the Belli, Copper Creek, Morrison Gulch, and Snow Gulch, with a combined yield in gold of $3,738. Among the small producers were the Gem Placer, at China Flat; Almo and Packer group, at Coffee; and B & J and Two Jacks, at Denny. The Trinity Consolidated Hydraulic Mining Co. is working the Union Hill mine at Douglas City, and other hydraulic mines at the same place are the O'Connell, Steiners Flat, and a few smaller ones. The combined output in gold of these mines was $39,409. Placer work on a small scale was carried on at Hayfork and Helena. At Junction City the hydraulic mines are the Chapman & Fisher Red Hill, and Valdor Mining Co., which with some smaller mines, made a combined gold yield of $10,905. At Lewiston, in addition to the Trinity Dredging Co., are the Jim Sing and the Trinity River mines. The Humboldt Placer Mining Co. is drifting in a small way at Minersville, and the McAtee Bar and the New River mining companies are hydraulicking at Quinby. The only producer of note at Trinity Center, aside from the Alta Bert dredge, is the Sykes Mining Co., operating a hydraulic mine. At and near Weaverville, the producers are the Democrat Gulch, Homestake-Ellerbrook Consolidated, and the La Grange, all hydraulic properties.

TUOLUMNE COUNTY.

Number of mines producing in Tuolumne County, Cal., quantity of ore sold or treated in 1905–1914, and total gold, silver, and lead produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	43	303,631	$1,298,888	19,076	.....	$1,310,410
1906	34	278,618	1,039,675	12,651	.....	1,048,151
1907	40	194,209	806,876	9,778	6,000	813,647
1908	50	263,216	798,752	22,136	.....	810,484
1909	53	288,618	925,703	8,430	.....	930,087
1910	43	197,737	615,626	10,655	.....	621,380
1911	63	308,652	1,093,484	24,987	.....	1,106,727
1912	53	228,823	1,113,291	40,888	.....	1,138,437
1913	32	236,062	974,409	40,366	.....	998,790
1914	33	222,507	940,793	21,731	.....	952,810
Increase (+) or decrease (−) in 1914	+1	−13,555	−33,616	−18,635	.....	−45,980

In Tuolumne County in 1914 there was an increase of one in the number of productive mines and a decrease in the output of both gold and silver. There was also a decrease in the quantity of ore

treated. The value of the total output of the county decreased by $45,980 in 1914, of which $33,616 was in gold. The county mines produced 45,510.86 ounces of gold, valued at $940,793, and 21,731 ounces of silver, valued at $12,017, a total of $952,810 in gold and silver, as compared with $998,790 in 1913. There were 33 producing mines in the county in 1914, all of which were deep gold mines—no placers—against 32 in 1913, an increase of 1. The decrease in the placer yield was $11,712.

The quantity of ore sold or treated in the county in 1914 amounted to 222,507 tons, or 13,555 tons less than in 1913. This ore yielded at the mills $595,623 in gold bullion, an average value of $2.68 a ton, and 17,454 fine ounces of silver, valued at $9,652, an average of $0.04 a ton, a total saving in mill bullion valued at $605,275, or an average of $2.72 a ton in gold and silver. From the milling ore 9,418 tons of concentrates were obtained, which yielded $337,561 in gold, an average value of $35.84 a ton, and 1,814 ounces of silver, valued at $1,003, an average of $0.11 a ton, a total of $338,564 in gold and silver, and a total average value of $35.95 a ton in gold and silver.

The ore milled and concentrated yielded a total value of $933,184 in gold, an average of $4.19 a ton, and 19,268 ounces of silver, valued at $10,655, or $0.05 a ton. The total yield of gold and silver on the plates and from the concentrates was valued at $943,839, or $4.24 a ton, as compared with $4.18 a ton in 1913.

The largest output of ore treated in Tuolumne County in 1914, was from the Harvard Mine (Inc.), at Jamestown, but the largest output of gold was from the Dutch Consolidated, at Quartz. The other large producers of the county were the Eagle Shawmut, at Shawmut; Black Oak, at Soulsbyville; and Jumper-California, at Stent. Small producers were the Gold Boy and Little Wonder, Longfellow, Big Casino, and Poco Tempo, at Big Oak Flat; Davis and Experimental Gulch, at Columbia; Gem, at Confidence; Cosmopolite, at Groveland; and Booker, Carlin, Wise, and Santa Ysabel, at Jamestown. The Harvard, at Jamestown, is opened by a vertical shaft 750 feet deep, below which is an incline to 1,700 feet. The mine is equipped with a 60-stamp amalgamation and concentration plant, and both mine and mill were operated the entire year. The Dutch Consolidated, owns the Dutch & Sweeney mines, adjoining each other. The property is opened by an incline shaft 1,800 feet deep and is equipped with a 40-stamp mill and concentrators. The Santa Ysabel, at Jamestown, was only worked a few months in 1914. The property is opened by 2 incline shafts, each 800 feet deep, and is equipped with a 40-stamp amalgamation and concentration mill. The Eagle-Shawmut, at Shawmut, is opened by a shaft 1,800 feet deep, a winze 600 feet deeper, and an adit of 1,100 feet. The reduction equipment consists of a 100-stamp amalgamation and concentration mill, and a 25-ton per day chlorination plant. The milling capacity was reduced during the year to 30 stamps, the working of low-grade ore having been discontinued owing to "shortening of working hours and workmen's compensation laws." The only mines at Sonora were small ones, the Belmont (pocket), Hope, and Sugarman. The Black Oak Mining & Development Co. at Soulsbyville, is opened by an incline shaft 1,720 feet deep, and during 1914 development work to the extent of 2,028 feet was accomplished. The mine has a 100-ton cyanide plant. The ore is crushed in solution

and is reground in tube mills. The mine was operated the entire year and the mill for 10 months. The Draper, at Soulsbyville, was unwatered in 1914, and active operations were begun. The north drift on the 600-foot level was extended 300 feet and a winze was sunk. The property is equipped with a 20-stamp amalgamation and concentration mill. The ore is hand sorted and is delivered to the stamps without previous crushing. The mill has been operated intermittently since August, 1914. The Jumper-California Mining Co., at Stent, has its property opened by a 1,400-foot incline shaft, 500-foot vertical shafts, and several small incline shafts, as well as by several miles of drifts. There is a 20-stamp mill on the property. The main workings were closed in April; the west vein was worked until July, when all work stopped. The mine was leased in blocks in September. The Dreisam, at Tuolumne City, is opened by an incline shaft 500 feet deep and has two 3-stamp batteries. The concentrates are not saved, but the tailings are being impounded. The mine has been idle since November, 1914, but is kept clear of water. A small output came from the Louisiana, at Tuolumne City, where mainly development work was done during the year. The Mohican did some shaft sinking and milled a small quantity of ore. The new Providence also made some output. The Star King and Sherman was worked for five months only, and the United Mines Corporation was a producer also. The United Leasing Co. commenced work February 10, 1914, and continued through the year. Most of the work done was in the way of development, but considerable gold was produced. The property has a 20-stamp amalgamation and concentration mill, with a 45-ton cyanide plant. At Tuttletown, the producers are the Atlas Consolidated, Orr and Santissimo, and Wilson and Means mines. The latter was operted under lease for six months. There are no reduction works at the mine, and the ore is shipped to a custom mill. During the year a 16-horsepower gas engine and hoist, and a 9 by 8 Giant compressor, were added.

Among the nonproducing mines the Bronx and Luella, at Columbia, was worked for eight months and the main tunnel was advanced 200 feet. The Stanislaus River Co. commenced work in December 1914. The Springfield Tunnel & Development Co. in 1914 drove 2,300 feet of bedrock tunnel to tap the gravel channel. The Gold Ship drift mine, 5 miles from Groveland, was worked for six months. On the Punch Bowl drift mine, at Jamestown, a long bedrock tunnel was being driven. On the Tanzy at Sonora, considerable work was performed without encountering any "pocket." On the Cherokee drift mine, Tuolumne City, "dead work" was done for five months and the property is reported productive in 1915. The El Oro mine, at the same place, in 1914, was equipped with electric hoist, compressor, and Jackhammer drills, and an electric line was built about one-third of a mile long to connect with the main line of the Tuolumne Transmission Co.

YUBA COUNTY.

Yuba County in 1914 held third place in rank of gold producers, being exceeded only by Nevada and Amador counties. It holds the leading position, however, in production of placer gold, entirely by reason of its gold-dredging activities. In 1913 Sacramento County held this position, but in 1914 Yuba County exceeded Sacramento

County by $634,365. The output of Yuba County in 1914 was 135,484.49 fine ounces of gold, valued at $2,800,713, and 9,575 ounces of silver, valued at $5,295, a total of $2,806,008, as compared with $2,499,076 in 1913, an increase of $306,932. The increase of gold from dredging operations was $335,279 in 1914, as compared with 1913. There were 12 dredges in operation in the county in 1914, the same number as in 1913. Altogether there were 25 productive placers, including these dredges, in operation during 1914, a decrease of 1 as compared with 1913. Aside from the dredges, there were 2 drift mines and 11 surface mines reporting production in 1914. There were also three productive deep mines. The deep-mine production in gold was $1,857 and 22 ounce of silver, valued at $12.

The largest producer in this county was the Yuba Consolidated Goldfields, which operated 10 dredges for six months and 9 dredges for six months along Yuba River, near Hammonton. The Marysville Dredging Co., the next in rank of production, had 2 dredges in operation. The Bright Star placer, in Browns Valley, has been sold to people interested in dredging. The American Mining & Development Co., drift mining at Snowden Hill, near Camptonville, operated from January 1 to June 15, 1914. There are a few small placers at Dobbins. Near Marysville are the following productive placers: Archimedes, Gilt Edge (since sold for dredging), Mammoth, and Sunset (sold for dredging in January, 1915). There are also some unimportant surface placers at Smartsville and Woodleaf. The few deep mines in this county were only small producers in 1914, and were the California Mother Lode Co., at Challenge; Lillian Francis, at Dobbins; and Red Cross, at Dobbins.

The following table shows the value of the output of gold by dredges from the Marysville field for several years, with the annual decrease or increase and the total:

Value of the mine production of gold of Marysville dredging district, California, 1903–1914, with increase (+) or decrease (−), by years.

Year.	Value.	Increase (+) or decrease (−).	Year.	Value.	Increase (+) or decrease (−).
1903	$25,736		1910	$3,172,476	+$730,557
1904	74,263	+ $48,527	1911	2,964,737	− 207,739
1905	188,967	+ 114,704	1912	2,716,197	− 248,540
1906	1,205,165	+1,016,198	1913	2,420,455	− 295,742
1907	1,688,032	+ 482,867	1914	2,755,734	+ 335,279
1908	1,969,079	+ 281,047			
1909	2,441,919	+ 472,840	Total	21,622,760	

OTHER COUNTIES.

Fresno County.—There were 4 deep mines operated productively in Fresno County in 1914, at Friant, Sanger, and Trimmer. Their combined output was $10,231 in gold and 56 ounces of silver, valued at $31.

Imperial County.—The few deep mines at Ogilby in Imperial County produced 41,763 tons of ore, yielding $210,428 in gold, 16,204 ounces of silver, valued at $8,961, and 11,414 pounds of copper, valued at $1,518, a total of $220,907.

Lassen and Modoc counties.—Two mines in Modoc County and 1 in Lassen produced, together, $1,777 in gold and 16 ounces of silver, valued at $9, a total of $1,786.

Madera County.—There were 4 deep mines and 1 placer productive in Madera County in 1914, which had a gold output of $4,506, and 62 ounces of silver, valued at $36, a total of $4,542. The mines were at O'Neals, Grub Gulch, and Ahwanee.

Merced and Stanislaus counties.—In these counties the output of the few gravel mines was $111,361 in gold, and the silver was 615 ounces, valued at $340, a total of $111,701.

Monterey County.—The output from deep-mining operations in this county in 1914 was $4,424 in gold and 34 ounces of silver, valued at $19, a total of $4,443.

Riverside County.—Four deep mines in Riverside County, at Banning, Blythe Junction, Indio, and Perris, produced 1,111 tons of ore that yielded $11,230 in gold, 161 ounces of silver, valued at $89, and 22 pounds of copper, valued at $3, a total value of $11,322.

GOLD, SILVER, COPPER, AND LEAD IN OREGON IN 1914.

(MINES REPORT.)

By Charles G. Yale.

PRODUCTION.

Number of mines producing in Oregon, quantity of ore sold or treated, 1905–1914, and total gold, silver, copper, and lead produced.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	233	150,268	$1,405,235	90,636	846,815	1,610	$1,592,156
1906	279	138,274	1,366,900	79,346	415,803	.....	1,500,212
1907	206	110,698	1,129,261	86,718	554,104	.....	1,297,316
1908	239	50,684	865,076	43,602	291,377	2,138	926,737
1909	162	59,281	781,964	27,827	235,000	400	827,001
1910	180	82,132	679,488	35,978	13,861	.....	700,676
1911	176	98,558	633,407	45,221	93,136	.....	669,016
1912	210	90,945	770,041	57,081	260,429	39,317	849,886
1913	173	155,901	1,627,710	179,036	43,330	87,207	1,746,402
1914	105	124,331	1,591,461	142,552	39,248	16,436	1,676,153
Decrease	−68	−31,570	−36,249	−36,484	−4,082	−70,771	−70,249

The most notable feature in the mining industry of Oregon in 1914 was the material decrease in the number of producing mines. There were 173 mines, large and small, in 1913; there were only 105 in 1914, a decrease of 68, or 39.3 per cent. This caused a decrease in total output, although the total metal yield of the State fell off only $70,249, or 4.02 per cent. The decrease in output of ore in 1914, as compared with 1913, was 31,570 tons; in gold, $36,249; in silver, 36,484 ounces; in copper, 4,082 pounds; and in lead, 70,771 pounds. The decrease in output of gold was due entirely to the deep mines, as the placer mines of the State showed an increase of $97,689, while the deep-mine production of gold was $133,938 less than in 1913, the net deficit being $36,249. The deep mines also produced $1,496 less in copper, $3,196 less in lead, and $29,038 less in silver than in 1913. The deep mines of the State were therefore responsible for a decrease in value of all metals of $167,668, while the placers increased in yield of gold $97,689, and decreased their yield of silver by $270, making a total gain of $97,419. The silver output in 1914 was 142,552 fine ounces, valued at $78,831, a decrease of $29,308 in value. The output of copper fell from 43,330 pounds in 1913 to 39,248 pounds in 1914, a decrease in value of $1,496. In production of lead the quantity in 1914 was 16,436 pounds, valued at $641, as compared with 87,207 pounds in 1913, valued at $3,837.

The gold values and the silver quantities in the table bear no relation to the quantity of ore for the reason that deep-mine and placer-mine gold and silver are combined to make the total. The production of gold in 1914 was $1,591,461, of which $1,043,144 was from deep mines and $548,317 from placers of various kinds. Of the total of 142,552 fine ounces of silver for that year, 137,040 came from deep mines and 5,512 from placers. In giving the number of producing mines both placers and deep mines are included.

The mine production in Oregon, having a total value of $1,676,153 in 1914, was derived from 105 producing mines, of which 77 were placers and 28 were deep mines. The producing placers decreased by 51 in 1914 and the producing deep mines by 17. The total quantity of ore mined and treated in 1914 was 124,331 tons, a decrease of 31,570 tons. The quantity of siliceous ore sold or treated was 124,274 tons, a decrease of 31,430 tons. There were no purely copper ores mined. The production of lead ores amounted to 57 tons, a decrease of 18 tons. The average value of the siliceous ore in 1914 was $8.99 a ton in gold and silver, as compared with $8.21 in 1913, $6.84 in 1912, $5.03 in 1911, $6.42 in 1910, $9.87 in 1909, and $12.49 in 1908. The small quantity of lead ore treated showed the high average value of $32.98 a ton in gold and silver. Altogether the 124,331 tons of ore had an average value per ton of about $9 in gold and silver.

There were treated at gold and silver mills in 1914 in Oregon 106,422 tons of ore, yielding $989,620 in gold and 55,004 fine ounces of silver, valued at $30,417. In milling the ore at gold and silver mills, $927,754 in gold and 53,454 fine ounces of silver were recovered by amalgamation and cyanidation, the average value per ton being $8.718 in gold and $0.278 in silver. From these 106,422 tons of milling ore were recovered 923 tons of concentrates, having a gold value of $61,866 and 1,550 fine ounces of silver, valued at $857, a total of $62,723, and an average value per ton of $67.03 in gold and of $0.929 in silver. In addition to this there were 12,815 tons of ore sent to concentrating mills, carrying $38,941 in gold and $37,915 in silver, a total of $76,856. All concentrates at gold and silver mills and at concentration mills included, there was a total of 1,439 tons of concentrates, carrying $100,807 in gold and 70,112 fine ounces of silver, valued at $38,772, an average per ton of $70.054 in gold and $26.944 in silver and a total of $96.998 in gold and silver. Of the crude ore treated at concentration and at gold and silver mills the average recovery from bullion and concentrates was $8.626 a ton in gold and $0.573 a ton in silver, a total of $9.199. Crude ore shipped to smelters amounted to 4,594 tons and contained $13,708 in gold and 13,469 ounces of silver, an average value per ton of $2.984 in gold and of $1.621 in silver. The 57 tons of lead ore shipped to smelters had an average gold and silver content of $32.98 and an average of 196 pounds of lead per ton. There were 500 tons of old tailings treated, yielding $875 in gold and 5 ounces of silver, valued at $3, an average value per ton of $1.75 in gold and $0.006 in silver.

GOLD.

The total recoverable gold content of ores and the gold from placers in Oregon in 1914 was 76,986.92 fine ounces, valued at $1,591,461, a decrease of 1,753.55 fine ounces in quantity and of $36,249 in value.

This decrease was due to the falling off in the ore production from the deep mines of the State, and amounts to 2.3 per cent. The largest yield of gold from one county, valued at $1,313,967, came from Baker County, as usual. The decrease in this county in 1914 was $59,513. The next county in rank of production of gold was Josephine, with $111,428, or an increase of $62,684. The other counties in rank of production of gold are Grant, Malheur, Jackson, Crook, Douglas, Lane, Coos, Wheeler, and Curry, in the order named. The placer mines of the State produced $548,317 in gold in 1914, as compared with $450,628 in 1913, an increase of $97,689. The hydraulic mines produced $178,899 in 1914, or $78,649 more than in 1913; the drift mines $4,426, or $17,396 less; the surface placers and dredge combined $364,992, or $36,436 more than in 1913. There was only 1 dredge operating in Oregon in 1914, but another has been built since by the same company. There were 56 productive hydraulic mines in 1914, as compared with 90 in 1913, yet the output was $78,649 greater than in 1913. There were 6 drift mines and 15 surface placers (including 1 dredge), the number of producing placers having fallen off more than one-half in 1914, as compared with 1913. The total output of gold from deep mines was 50,462.09 fine ounces, valued at $1,043,144, which was 6,479.25 ounces less in quantity and $133,938 less in value in 1914 than in 1913.

The mine production of gold in fine ounces, with classification of ores and increase and decrease, for 1913 and 1914, follows:

Mine production of gold in Oregon in 1913 and 1914, by kinds of ore, in fine ounces.

Year.	Placers.	Deep mines.				Grand total.	
		Siliceous ore.	Copper. ore.	Lead ore.	Total.	Quantity.	Value.
1913	21,799.13	56,781.36	99.99	59.99	56,941.34	78,740.47	$1,627,710
1914	26,524.83	50,388.32	.....	73.77	50,462.09	76,986.92	1,591,461
Increase (+) or decrease (−)	+4,725.70	−6,393.04	−99.99	+13.78	−6,479.25	−1,753.55	−36,249

The gold production from different kinds of mines, by counties, for 1914, is given in the following table:

Source of production of gold in Oregon, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ore.	Lead ore.	Total.	
Baker	17,873.69	45,615.69	.....	73.77	45,689.46	63,563.15
Coos	57.37	.....	.....	.....	.....	57.37
Crook	181.65	145.32	.....	.....	145.32	326.97
Curry	29.56	.....	.....	.....	.....	29.56
Douglas	125.58	103.09	.....	.....	103.09	228.67
Grant	998.65	1,898.91	.....	.....	1,898.91	2,897.56
Jackson	1,632.75	278.35	.....	.....	278.35	1,911.10
Josephine	5,006.43	383.90	.....	.....	383.90	5,390.33
Lane	.....	127.08	.....	.....	127.08	127.08
Malheur	585.29	1,835.98	.....	.....	1,835.98	2,421.27
Wheeler	33.86	.....	.....	.....	.....	33.86
Total	26,524.83	50,388.32	.....	73.77	50,462.09	76,986.92
Increase (+) or decrease (−)	+4,725.70	−6,393.04	−99.99	+13.78	−6,479.25	−1,753.55

The following table shows the output of placer gold by classes of mines in Oregon, by counties, in 1914:

Value of output of placer gold in Oregon in 1914, by counties, by classes of mines.

County.	Hydraulic.	Drift.	Surface and dredge.	Total.
Baker	$17,244	$3,670	$348,568	$369,482
Coos	109	.....	1,077	1,186
Crook	.....	.....	3,755	3,755
Curry	611	.....	.....	611
Douglas	2,596	.....	.....	2,596
Grant	20,644	.....	.....	20,644
Jackson	31,476	756	1,520	33,752
Josephine	99,683	.....	3,809	103,492
Malheur	5,836	.....	6,263	12,099
Wheeler	700	.....	.....	700
Total	178,899	4,426	364,992	548,317

The following table shows the increase or decrease in value of production of gold in Oregon in 1914, by counties:

Increase or decrease in value of production of gold in Oregon in 1914, by counties.

County.	Increase.	Decrease.
Baker	.....	$59,513
Coos	.....	438
Crook	$1,583	.....
Curry	.....	4,849
Douglas	2,061	.....
Grant	.....	3,754
Jackson	2,570	.....
Josephine	62,684	.....
Lane	.....	4,471
Malheur	.....	31,989
Wheeler	.....	133
Total	68,898	105,147
Net decrease in 1914	.....	36,249

From the siliceous ore in Oregon in 1914 the recovery of gold by processes was as follows: By amalgamation, $333,768; by cyanidation, $594,861. There are no chlorination plants, and the concentrates were shipped to smelters for treatment.

SILVER.

The recoverable silver content of ores and the silver from placers in Oregon in 1914 aggregated 142,552 fine ounces, valued at $78,831, a decrease of 36,484 ounces in quantity and of $29,308 in value, as compared with the production in 1913. Grant County in 1914, as in 1913, made the largest output of silver, 68,556 fine ounces, valued at $37,911. Baker County was next in rank, the output of silver in 1914 being 58,267 ounces, valued at $32,222, which was 20,915 ounces less in quantity and $15,604 less in value than in 1913. Josephine County produced 13,078 ounces of silver in 1914, valued at $7,232, and Malheur County 2,279 ounces, valued at $1,260; the other counties of the State produced only nominal quantities. The placer mines of Oregon produced 5,512 fine ounces, valued at $3,048, as compared with 5,493 ounces, valued at $3,318 in 1913. The deep mines produced 137,040 fine ounces, valued at $75,783; of this quan-

tity 642 ounces were derived from lead ores, the remainder, 136,398 ounces, being derived from siliceous ore. The placer silver for 1914 was valued at only a few hundred dollars less than in 1913, the decrease in the State being mainly from the deep mines. From the siliceous ore and old tailings treated in Oregon in 1914 the recovery of silver by amalgamation was 2,599 fine ounces and by cyanidation 50,861 ounces.

The source of silver by kinds of ore and by counties, in 1914, is shown in the table following:

Source of production of silver in Oregon, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ore.	Lead ore.	Total.	
Baker	4,450	53,175	.....	642	53,817	58,267
Coos	11	.....	.....	.....	.....	11
Crook	11	11	.....	.....	11	22
Curry	4	.....	.....	.....	.....	4
Douglas	18	23	.....	.....	23	41
Grant	118	68,438	.....	.....	68,438	68,556
Jackson	231	40	.....	.....	40	271
Josephine	579	12,499	.....	.....	12,499	13,078
Lane	.....	9	.....	.....	9	9
Malheur	76	2,203	.....	.....	2,203	2,279
Wheeler	14	.....	.....	.....	.....	14
Total	5,512	136,398	.....	642	137,040	142,552
Increase (+) or decrease (−)	+19	−36,559	−154	+210	−36,503	−36,484

COPPER.

The mine production of copper in Oregon in 1914 was 39,248 pounds, valued at $5,220, a decrease of 4,082 pounds in quantity and of $1,496 in value.

LEAD.

In 1914 Oregon produced only 16,436 pounds of lead, valued at $641, as compared with 87,207 pounds, valued at $3,837, in 1913. Lead was produced in three counties of the State—Baker, Grant, and Jackson.

MINING INDUSTRY IN OREGON IN 1914.

Oregon produced less gold and silver in 1914 than it did in 1913, but the percentage was not large, and the decrease was due to a smaller number of mines being worked rather than to a falling off in production of those operated. With the exception of the year 1913, Oregon produced in 1914 more gold and silver than in any year since 1902. Indeed, the figures of 1913 showed an output of gold 111 per cent greater than the output of 1912. There were 105 productive mines in the State reporting in 1914, as compared with 173 in 1913. The placer mines increased their output of gold in 1914, as compared with 1913, by $97,689, but the deep mines decreased their yield in the same period by $133,938, thus leaving a total gold deficit for the year 1914 of $36,249. It took 77 placer mines of various kinds, large and small, to produce $548,317 in gold; 28 deep mines produced $1,043,144. From letters received from miners during the period of

this inquiry, it is evident that capital is badly needed in Oregon for the development and equipment of mining properties.

What may be called extensive mining properties are few in number in Oregon, most mining operations being on a small scale. There are only 4 mines in the State that produce more than $100,000 each, all in Baker County. These are the Cornucopia Mines Co., Columbia Mines Co., and Commercial Mining Co. (Rainbow) for the deep mines, and the Powder River dredge for the placers. Aside from the dredge, only one placer mine in the State produced more than $10,000 in 1914.

The southwestern counties of Oregon,[1] which form an extension of the California gold belt, are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. These counties (with the exception of Benton, from which no product was reported), made in 1914 a combined production of $160,085 in gold and 13,414 ounces of silver, valued at $7,418. The production of placer gold in this region in 1914 was $141,637, an increase of $69,921, and the production of gold from deep mines was $18,448, a decrease of $12,364. The total increase in output of gold in these southwestern counties in 1914, as compared with 1913, was, therefore, $57,557.

Northeastern Oregon comprises the counties of Baker, Crook, Grant, Harney, Malheur, Umatilla, Union, Wallowa, and Wheeler. In 1914 the counties of Harney, Umatilla, Union, and Wallowa made no metallic output. The combined gold output of the five producing counties of this region—Baker, Crook, Grant, Malheur, and Wheeler—in 1914 was $1,431,376, of which Baker County contributed $1,313,967, or nearly 92 per cent. This was a decrease for 1914 of these counties, as compared with 1913, of $93,806. The placer gold yield for 1914 was $406,680, an increase of $27,768, or 6.83 per cent. The lode mines produced in gold $1,024,696 in 1914, as compared with $1,146,270 in 1913, a decrease of $121,574, or 10.61 per cent.

The subdivision of ore and production of gold and silver in Oregon in 1914, according to methods of treatment, is shown in the following table:

Subdivision of ore and production of gold and silver in Oregon in 1914, according to methods of treatment, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates treated.		
	Quantity.	Gold.	Silver.		Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*	*Short tons.*		*Fine ounces.*
Baker	97,448	$885,950	52,835	170	810	$54,220	327
Crook	300	3,004	11	.....	.....	.....	.....
Douglas	131	1,261	19	.....	.....	.....	.....
Grant	2	350	4	12,645	509	38,029	68,429
Jackson	128	4,412	22	.....	.....	.....	.....
Josephine	81	2,367	16	.....	.....	.....	.....
Lane	500	2,627	9	.....	.....	.....	.....
Malheur	7,832	27,783	538	.....	120	8,558	1,356
Total	106,422	927,754	53,454	12,815	1,439	100,807	70,112
Average per ton	.....	$8.72	$0.278	.....	.....	$70.05	$26.94

[1] Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, pp. 9–127, 1914. Diller, J. S., and Kay, G. F., Mines of the Riddles Quadrangle, Oregon: U. S. Geol. Survey Bull. 340, pp. 134–152, 1908.

Subdivision of ore and production of gold and silver in Oregon in 1914, according to metods of treatment, by counties—Continued.

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*		*Fine ounces.*
Baker	104	$4,315	655			
Crook						
Douglas	15	870	4			
Grant				500	$875	5
Jackson	137	1,342	18			
Josephine	4,336	5,569	12,483			
Lane						
Malheur	2	1,612	309			
Total	4,594	13,708	13,469	500	875	5
Average value per ton		$2.98	$1.62		$1.75	$0.0055

Average recovery value per ton from both bullion and concentrates: Gold, $8.63; silver, $0.57.

The total quantity, by kinds, of ore sold or treated in each county in Oregon in 1914, is shown in the following table:

Subdivision of ore sold or treated in Oregon in 1914, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Total ore.
Baker	97,665		57	97,722
Crook	300			300
Douglas	146			146
Grant	13,147			13,147
Jackson	265			265
Josephine	4,417			4,417
Lane	500			500
Malheur	7,834			7,834
Total	124,274		57	124,331
Decrease (−)	−31,430	−122	−18	−31,570
Value per ton in gold and silver	$3.99		$32.98	$9.00

The following table gives the number of producing mines, classified according to their chief product, in the counties of Oregon in 1914:

Number of mines classified by chief product in Oregon in 1914, by counties.

County.	Gold placer mines.				Deep mines.					Total producing mines.
	Hydraulic.	Drift.	Surface.	Total.	Gold.	Silver.	Copper.	Lead.	Total.	
Baker	12	4	3	19	11			1	12	31
Coos	1		3	4						4
Crook			1	1	1				1	2
Curry	1			1						1
Douglas	6			6	2				2	8
Grant	3			3	3				3	6
Jackson	8	2	2	12	4				4	16
Josephine	19		5	24	4				4	28
Lane					1				1	1
Malheur	5		1	6	1				1	7
Wheeler	1			1						1
Total	56	6	15	77	27			1	28	105

The following table shows the mine production of gold, silver, copper, and lead and the quantity of ore treated in Oregon in 1914, by counties:

Production of precious metals in Oregon in 1914, by source and counties, and production of copper and lead, by counties.

County.	Ore.	Quartz gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ozs.*		*Fine ozs.*		*Fine ozs.*	
Baker	97,722	45,689.46	$944,485	17,873.69	$369,482	63,563.15	$1,313,967
Coos				57.37	1,186	57.37	1,186
Crook	300	145.32	3,004	181.65	3,755	326.97	6,759
Curry				29.56	611	29.56	611
Douglas	146	103.09	2,131	125.58	2,596	228.67	4,727
Grant	13,147	1,898.91	39,254	998.65	20,644	2,897.56	59,898
Jackson	265	278.35	5,754	1,632.75	33,752	1,911.10	39,506
Josephine	4,417	383.90	7,936	5,006.43	103,492	5,390.33	111,428
Lane	500	127.08	2,627			127.08	2,627
Malheur	7,834	1,835.98	37,953	585.29	12,099	2,421.27	50,052
Wheeler				33.86	700	33.86	700
Total	124,331	50,462.09	1,043,144	26,524.83	548,317	76,986.92	1,591,461

County.	Quartz silver.		Placer silver.		Total silver.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Fine ozs.*	
Baker	53,817	$29,761	4,450	$2,461	58,267	$32,222
Coos			11	6	11	6
Crook	11	6	11	6	22	12
Curry			4	2	4	2
Douglas	23	13	18	10	41	23
Grant	68,438	37,846	118	65	68,556	37,911
Jackson	40	22	231	128	271	150
Josephine	12,499	6,912	579	320	13,078	7,232
Lane	9	5			9	5
Malheur	2,203	1,218	76	42	2,279	1,260
Wheeler			14	8	14	8
Total	137,040	75,783	5,512	3,048	142,552	78,831

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Baker	692	$92	11,179	$436	$1,346,717
Coos					1,192
Crook					6,771
Curry					613
Douglas					4,750
Grant	406	54	154	6	97,869
Jackson			5,103	199	39,855
Josephine	38,150	5,074			123,734
Lane					2,632
Malheur					51,312
Wheeler					708
Total	39,248	5,220	16,436	641	1,676,153

PRODUCTION BY COUNTIES.[1]

BAKER COUNTY.

Mine production of gold, silver, copper, and lead in Baker County, Oreg., 1905–1914.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	37	75,053	$771,607	55,161	3,200	.....	$805,423
1906	51	58,889	795,653	53,708	185	.....	736,673
1907	46	69,881	631,045	69,589	.....	.....	676,974
1908	50	38,413	507,929	17,495	.....	.....	517,202
1909	42	32,521	417,538	19,514	.....	.....	427,685
1910	54	56,263	401,002	29,835	13,861	.....	418,873
1911	34	74,558	389,786	30,944	.....	.....	406,186
1912	49	70,631	484,041	39,140	951	.....	507,269
1913	41	117,040	1,373,480	79,182	2,783	19,796	1,422,608
1914	31	97,722	1,313,967	58,267	692	11,179	1,346,717
Decrease (−)	−10	−19,318	−59,513	−20,915	−2,091	−8,617	−75,891

The total value of all metals mined in Baker County in 1914 was $1,346,717, as compared with $1,422,608 for 1913, a decrease of $75,891. This was almost entirely due to the decreased output of ore from the deep mines, which produced 19,318 tons less than in 1913. This resulted in a decrease of $59,513 in gold and of 20,915 ounces of silver in 1914, as compared with 1913, and a nominal decrease of copper and lead. There were 31 producing mines in the county in 1914, a decrease of 10 as compared with 1913. The placers numbered 19, of which 12 were hydraulic, 4 were drift, and 3 were sluicing or surface mines, including 1 dredge. These placers produced $369,482 in gold and 4,450 ounces of silver, valued at $2,461, as compared with $359,701 in gold and 4,275 ounces of silver in 1913, an increase for 1914 from placers of $9,781 in gold and a decrease of $121 in silver value, as compared with 1913. There were 19 producing placers in the county in 1914, as compared with 27 in 1913. The number of producing deep mines was 12, or 2 less than in 1913. The total output of siliceous ore mined and treated in the county in 1914 was 97,665 tons, or 19,375 tons less than in 1913. The gold from this ore was valued at $942,960 and the silver, 53,175 ounces, was valued at $29,406. The average recoverable value of the ore per ton was $9.66 in gold and 30 cents in silver, a total value per ton of $9.96 in 1914, as compared with $8.66 in gold and 39 cents in silver, a total of $9.05 in 1913, $6.32 in gold and 34 cents in silver, a total of $6.66 in 1912, and $4.99 in gold and 22 cents in silver, a total of $5.21 in 1911. Of the 97,665 tons of siliceous ore, 97,448

[1] For reference to United States Geological Survey publications on the mining districts of Oregon, see Hill, J. M., The mining districts of the western United States: U. S. Geol. Survey Bull. 507, 1912.
See also Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, 1914.
See also publications on the mineral resources of Oregon by the Oregon Bureau of Mines and Geology, 526 Yeon Building, Portland, Oreg., as follows:
Collier, A. J., Geology and mineral resources of the John Day region, vol. 1, No. 3, March, 1914.
Winchell, A. N., Petrology and mineral resources of Jackson and Josephine counties, vol. 1, No. 5, August, 1914.
Pardee, J. T., and Hewett, D. F., Geology and mineral resources of the Sumpter quadrangle, vol. 1, No. 6, October, 1914.
Grant, U. S., and Cady, G. H., Preliminary report on the geology of the Baker district of eastern Oregon; vol. 1, No. 6, October, 1914.
Swartley, A. M., Ore deposits of northeastern Oregon, vol. 1, No. 8, December, 1914.

tons were treated at gold and silver mills and produced $885,950 in gold and 52,835 ounces of silver (valued at $29,218) by amalgamation and cyanidation, an average per ton of $9.09 in gold and 30 cents in silver. From the 97,448 tons of milling ore were derived 803 tons of concentrates producing $53,308 in gold and 193 ounces of silver (valued at $107), a total value of $53,415, or an average per ton of $66.52. The total yield of the 97,448 tons of milling ore from the plates, from direct cyanidation, and from the concentrates, was $939,258 in gold and $29,325 in silver, an average per ton of $9.64 in gold and 30 cents in silver, a total recovery per ton of $9.94 in gold and silver. In addition to this, 170 tons of ore were sent to concentrating mills, which produced 7 tons of concentrates, from which $912 in gold and 134 ounces of silver, valued at $74, were obtained, an average value per ton of concentrates in gold and silver of $140.86. Crude ore was shipped to smelters to the amount of 104 tons, and yielded in gold $4,315 and in silver 655 ounces, valued at $362, a total value for smelting ores of $4,677 in gold and silver, or an average per ton of $44.97. There were no reports received of any old tailings having been treated in 1914.

Baker district.—Only two placer mines were productive in this district in 1914, their output being $11,703 in gold and $37 in silver. In 1913 the yield from the district was $133,736 when there were 8 producing mines, including 4 deep mines, but these deep mines were all idle in 1914.

Cable Cove district.—Only two mines were productive in Cable Cove district in 1914—the Blue Mountain Mines Co. and the Imperial. The Blue Mountain Mines Co. worked the Last Chance mine in a small way, using an experimental plant. Installation of a 20-stamp mill began in 1914, but was delayed on account of the severity of the winter. The Imperial was worked until September, 1914, when the lease was abandoned and the mine was closed.

Connor Creek district.—The principal producing placers were the Neversweat and the Huntington, both drift mines.

Cornucopia district.—Six deep mines and 1 placer made a combined output of $437,839 in gold and silver in 1914. The Boulder Creek, at Halfway, is a hydraulic mine. The Cornucopia Mines Co., of New York, operates the most important of the deep mines. The company deepened a shaft by 140 feet and ran 2,000 feet of drifts in 1914. It has a 100-ton cyanide plant, and 20 stamps, 2 tube mills with agitators, filters, thickeners, and clarifying press. Other deep mines which were productive were the Baker Mines Co., Mayflower, Bonanzo, Klein, and West Side Gold & Silver Mining Co. The last company shipped small lots of ore to custom mills near Greenhorn, but is not likely to ship any more. A reduction plant is required.

Cracker Creek district.—This is the most productive district in Oregon, the 2 deep mines and 5 placers having in 1914 a total output in gold and silver valued at $459,823, of which $457,170 was gold. The output of the district in 1913 was valued at $601,287. The principal deep mine is that of the Columbia Gold Mining Co., at Sumpter, which has been in operation for 18 years. At this property the vertical shaft is 918 feet deep, the adit 3,000 feet long, and there are 30,000 feet of drifts. The ore is crushed at the mill, concentrates are shipped to the smelter, and tailings are treated at the cyanide plant. The main placers in the district are the Clark Creek

Farm, hydraulic; Surprise, drift; Buck Gulch, hydraulic; and the claims of the Powder River Gold Dredging Co. This last company is operating the only dredge in Oregon, and quite successfully. During the year the construction of a smaller dredge was begun on the property downstream from Sumpter. The deposit being mined is a belt of gravel from 300 to 2,000 feet in width on the bottom lands of the Sumpter Valley. The depth of the gravel is from 12 to 28 feet under about 3 feet of soil. The layer of gravel next to bedrock is "cemented." The gold is found in fine flaky particles with no nuggets, and there are no bowlders to contend with.

Greenhorn district.—Two small placers reported production of less than $3,000 in 1914 from this district.

Mormon Basin district.—Four mines were productive in this district in 1914, of which 2 were placers and 2 deep mines. The Commercial Mining Co., operating the Rainbow mine, at Rye Valley, has the most productive mine in the State. During 1914 the fourth level was explored, and some lateral prospecting work was also carried on. The property is equipped with a 100-ton amalgamation and cyanide plant.

Pine Creek district.—The small hydraulic mines in this district are the Bulldog, Burnt River Mining Co., Gold Nugget, and Hamm Gold Mining Co., which made a combined output in 1914 of $6,193 in gold and silver.

COOS, CROOK, AND CURRY COUNTIES.

In Coos County are 4 small placers, the Independence, Bullard, Sweet Bros., and Whisky Run. These are all operating on ocean beach sands. In Crook County the Ochocho placer was a producer at Redmond, in Howard district; and the Mayflower Mining Co. has a deep mine at Howard, in the same district. The mill operated only a short time in 1914 concentrating the low-grade ore and shipping the concentrates to a smelter. The only producer reporting from Curry County was the Gold Bar hydraulic, at Illahe.

DOUGLAS COUNTY.

Only half as many hydraulic mines were productive in this county in 1914 as in 1913. These were the Mosthoff, in Excelsior district; Coffee Creek & Texas, in Coffee Creek district; and the Bowlder, the Starvout Nugget, and the Legal Tender, in Green Mountain district. There were also 2 deep mines productive in a small way, the Oregon Mines Corporation, in Bohemia district, and the Little Chieftain, in Myrtle Creek district. The total output of the county in gold and silver was $4,750, which was $2,070 more than in 1913.

GRANT COUNTY.

The production from Grant County in 1914 amounted to $59,898 in gold, 68,556 ounces of silver, valued at $37,911, and nominal quantities of copper and lead, the total output being valued at $97,869, or $21,217 less than in 1913. This brings Grant third in rank among the producing counties, as it yields second place to Josephine County with a total output valued at $123,734. There were only 3 deep

mines and 3 hydraulic mines reporting production in the county in 1914. The number of deep producing mines was the same as in 1913, but there were 14 less placers. Those at work are at Canyon City, Granite, and Austin. The deep mines are the Ben Harrison and the Red Boy mines at Granite, and the Belmont, at Austin. The Ben Harrison is the most important and the largest producer in the county. The mine is developed by a 600-foot shaft, an adit 734 feet long, and about 11,000 feet of drifts. The Red Boy was not in operation during the year, but some hundreds of tons of old tailings were worked.

JACKSON COUNTY.

There were 4 producing deep mines in Jackson County and 12 placers, or 5 less deep mines and 5 less placers than were reported in 1913. Most of the placers are hydraulic mines, although 2 of them are worked by the drifting process. These placers produced $33,752 in gold and $128 in silver, a total of $33,880 and an increase of $11,739 over 1913, notwithstanding there were fewer producing mines. The Layton hydraulic mine, in Applegate district, was the largest producer. The deep mines of the county made a production of only 265 tons of ore, from which was derived $5,754 in gold and 40 ounces of silver, a total value of $5,776, as compared with $15,494 in 1913, a decrease of $9,718. The value of the output of the county in 1914 (including a small quantity of lead) was $39,855, or $2,201 more than in 1913. In Applegate district the Afterthought was worked by lessees and the ore was crushed at a custom mill. Some ore was worked in an arrastra from a mine owned by the Pernoll estate. The hydraulic mines operated were the Layton, Humbug, and a few smaller ones. The total output of the district in gold and silver was $18,825. In Foots Creek district the Black Channel hydraulic mine was the only producer. Forest Creek district reported placer production from the Ray, Vance, and Spaulding mines, the total being $13,200 in gold and silver. Two placers in Jacksonville district made only a nominal yield. The Gold Ridge quartz mine was a producer in Kanes Creek district, and the Pearl Mining Co., in Pearl district, made a small production, using a Huntington mill and Johnson concentrators. Some small hydraulic mines were worked in Pleasant Creek district, and the Sperry or Maybright hydraulic was worked in Sardine Creek district.

JOSEPHINE COUNTY.

The total output of gold, silver, and copper in Josephine County in 1914 was valued at $123,734, as compared with $54,373 in 1913, an increase of $69,361. The gold yield was $111,428, the silver 13,078 ounces, valued at $7,232, and the copper 38,150 pounds, valued at $5,074. The 4 deep mines of the county produced from 4,417 tons of ore, $7,936 in gold, 12,499 ounces of silver, valued at $6,912, and 38,150 pounds of copper, valued at $5,074. The total value of the deep-mine product of the county was, therefore, $19,922. Of the placer gold total of $103,492, the hydraulic mines produced $99,683, the balance of $3,809 coming from surface placers. The increase in placer gold in the county in 1914 was $62,296. The increase in total production of gold for 1914, as compared with 1913, was $62,684.

Of the ore produced, 81 tons were treated at gold and silver mills and 4,336 tons were shipped to smelters. It is to be noted that this smelting ore was produced in 1913 (from a mine idle in 1914), but that the returns from the smelter were not received until after the preparation of the report for 1913.

A table follows which shows the output of metals from the various districts of Josephine County in 1914. The copper yield is stated separately and deducted from totals of districts in which it is mined, to conceal individual outputs of certain mines.

Value of output of gold and silver and quantity and value of copper produced in Josephine County, Oreg., mining districts in 1914.

District and county.	Placer gold.	Quartz gold.	Placer silver.	Quartz silver.	Copper.		Total.
					Quantity.	Value.	
					Pounds.		
Althouse	$3,387		$9				$3,396
Applegate	600		3				603
Briggs Creek	2,400		6				2,406
Galice	6,822	$5,569	24	$6,903			19,318
Grave Creek	3,438		11				3,449
Josephine	5,299		20				5,319
Jump-off-Joe	39,667	200	123	1			39,991
Picket Creek	109		1				110
Sucker Creek		1,660		6			1,666
Waldo	37,565	507	112	2			38,186
Williams	1,782		3				1,785
Wolf Creek	2,423		8				2,431
County total					38,150	$5,074	5,074
Total	103,492	7,936	320	6,912	38,150	5,074	123,734

The producing mines in Althouse district are all placers and are the Deadwood Gulch, Goldsby, and Little Homestead.

In the Galice district there are 3 placers, the Crescent and Extension, Martin & Daniels, and Taylor Creek. The Almeda deep mine in this district made no output in 1914.

In Grave Creek district the two principal hydraulic mines are the Archer and the Goff Abbott, and there are also some smaller mines.

Josephine district has 4 productive hydraulic mines, the Canyon Creek, Gold Leaf group, Junction, and Anderson.

The only deep mine operating in Jump-off-Joe district is the Goodnow. The two hydraulic mines are the Cook and Howland and the Swastika Mining Co.

There are 2 hydraulic mines in Waldo district, the Deep Gravel Mining Co. and the Osgood. The only deep productive mine in the district is the Horsehead.

In Applegate district there is 1 productive hydraulic mine; in Briggs Creek district, 1 hydraulic mine; Picket Creek district, 1 hydraulic mine; Sucker Creek district, 1 deep mine; Williams district, 1 hydraulic mine; and in Wolf Creek district, 2 hydraulic mines.

LANE, MALHEUR, AND WHEELER COUNTIES.

In 1913 Lane County produced 127.08 fine ounces of gold, valued at $2,627, and 9 ounces of silver, valued at $5, a total of $2,632, as compared with a total of $11,975 in 1913 (including copper and lead),

a decrease of $9,343. There were no placers worked in 1914 and no output of copper and lead, as there was in 1913. The only returns received were from Bohemia district.

Returns received from Malheur County in 1914 were from 6 placers and 1 deep mine in Malheur Basin and Mormon Basin districts. The total output of gold for the year was $50,052 and the silver was 2,279 fine ounces, valued at $1,260, a total of $51,312, as compared with $84,067 in 1913, a decrease in gold and silver of $32,755. The Humboldt Consolidated Gold Mines, the most important mining property in the county, added 10 stamps, a Hardinge mill, and 5 concentrators to its reduction equipment in 1914, the mill now having 20 stamps. The placers of the county are the Moy Kee, Littig, and Quartz Gulch hydraulic mines in Malheur Basin district, and the Archer and Hansen, Glengarry, and some few small mines in Mormon Basin district.

In Wheeler County the production for the year was $700 in gold and 14 ounces of silver, valued at $8, a total of $708—somewhat less than in 1913. The gold and silver came from placers in Spanish Gulch district.

METALS AND ORES IN 1913 AND 1914.

By J. P. Dunlop.

INTRODUCTION.

In the detailed chapters on the various metals in Part I of Mineral Resources of the United States (to which the reader should refer for full information on the metallic resources and industries) the production is measured in terms of the customary unit, whether the long ton of 2,240 pounds, the metric ton of 2,204.6 pounds, the short ton of 2,000 pounds, the "flask" of 75 pounds, the avoirdupois pound, or the troy ounce. The long ton is used for iron ore, bauxite, pig iron, and steel, particularly in the Eastern States, and for tin, copper, and spelter in England. The metric ton is used on the Continent of Europe, in Mexico, and wherever the metric system is in vogue. The "flask" is the customary unit for the measurement of quicksilver except where the metric ton is used; the avoirdupois pound is the unit referred to in defining the tons and the "flask," and is also used for measuring the output of copper, lead, spelter, aluminum, nickel, and so on; the short ton is used for both ore and concentrates in the West, as well as for lead and spelter; and the troy ounce is used for gold, silver, and platinum and allied rare metals. Were the metric system in commercial use in the United States, this confusion of terms would be avoided; in its absence the production of this country by metal mines and metallurgical plants is summarized, as stated, in terms of the short ton of 2,000 pounds.

The table of production of metals gives in the main the output from plants—mills, smelters, and refineries—in the United States and is essentially a measure of the metallurgical industry, as the supplies of ore, matte, and unrefined bullion treated in this country are derived from both domestic and foreign sources. The attempt is made at subdivision of these two sources, however, and the production in marketable form of metals from both domestic and foreign mines is therefore given wherever possible. The table of production of domestic ore is a measure of the metal-mining industry of the United States alone.

There are, roughly, four stages to be considered in the production of metal in marketable form from crude ore—(1) mining, (2) milling and concentrating, (3) smelting, and (4) refining. The first stage produces crude ore; and both straight concentrating and gold and silver milling plants produce concentrates. Both crude ore and concentrates are treated in both gold and silver amalgamating, cyaniding, and chlorinating plants, and also in smelters, and the products are refined in private refineries and the precious metals in part in the

United States mints. Production may be reported, therefore, as metal in raw materials, in unrefined state, or as refined, and thus there may be three sets of figures to represent the metal output, and there may be certain discrepancies between these for the same metal for the same calendar year, owing to time difference, customary losses in metallurgical operations, and difference in activity between mining and treating the ore. In this summary the metals are measured as refined.

METALS.

The following table shows the production of metals in the United States in 1912, 1913, and 1914.

Production of metals in the United States in 1912, 1913, and 1914, in short tons.

1912.

Metal.	Production from domestic ores.		Production from foreign ores, matte, and unrefined bullion smelted or refined in the United States.		Total production.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Iron (pig) [a]	32,458,938	$402,378,453	1,343,747	$18,184,935	33,802,685	$420,563,388
Manganese (spiegeleisen and ferromanganese)	114,868	1,962,955	140,423	6,319,051	255,291	8,282,006
Other ferro-alloys [b]	109,202	1,901,707	3,633	2,040,063	112,835	3,941,770
Nickel [c]			22,421	17,936,800	22,421	17,936,800
Aluminum [d]	32,803	11,907,000			32,803	11,907,000
Gold	154.996	93,451,500	33.112	19,964,010	188.108	113,415,510
Silver	2,186.291	39,197,500	2,285.147	40,989,817	4,471.438	80,187,317
Platinum	.032	23.003	1.318	1,709,218	1.350	1,732.221
Quicksilver	939.900	1,053,941			939.900	1,053,941
Tin			8.400	8,850	8.400	8,850
Copper, stated as refined	601,838	198,606,540	132,214	43,630,620	734,052	242,237,160
Lead, stated as refined	392,517	35,326,530	88,377	7,953,930	480,894	43,280,460
Antimonial lead	8,549	826,788	5,003	484,560	13,552	1,311,348
Zinc, stated as spelter	323,907	44,699,166	14,899	2,056,062	338,806	46,755,228
Total		831,335,083		161,277,916		992,612,999

1913.

Iron (pig) [a]	32,642,438	$439,633,756	1,393,169	$18,708,589	34,035,607	$458,342,345
Manganese (spiegeleisen and ferromanganese)	119,818	2,468,713	133,834	6,803,556	253,652	9,272,269
Other ferro-alloys [b]	75,835	2,184,965	2,265	1,558,128	78,100	3,743,093
Nickel [c]			23,562	18,849,600	23,562	18,849,600
Aluminum [d]	36,190	13,845,000			36,190	13,845,000
Gold	146.278	88,884,400	32.025	18,619,535	178.303	107,503,935
Silver	2,290.337	40,348,100	1,738.583	30,628,049	4,028.920	70,976,149
Platinum and allied metals	.035	46,530	1.342	1,761,930	1.377	1,808,460
Quicksilver	758	813,171			758	813,171
Tin	2.5	2,250			2.5	2,250
Copper, stated as refined	618,412	191,707,720	189,122	58,627,820	807,534	250,335,540
Lead, stated as refined	411,878	36,245,264	50,582	4,451,216	462,460	40,696,480
Antimonial lead	14,667	1,398,971	1,998	192,883	16,665	1,591,854
Zinc, stated as spelter	337,252	37,772,224	9,424	1,055,488	346,676	38,827,712
Total		855,351,064		161,256,794		1,016,607,858

[a] Marketed production.
[b] Includes marketed production of ferrosilicon, ferrophosphorus, ferrovanadium, ferrotungsten, ferromolybdenum, ferrotitanium. No ferrotitanium reported for 1914.
[c] Nickel content of imported matte and ore.
[d] Foreign included in domestic. Figures are consumption, not production.

Production of metals in the United States in 1912, 1913, and 1914, in short tons—Continued.

1914.

Metal.	Production from domestic ores.		Production from foreign ores, matte, and unrefined bullion smelted or refined in the United States.		Total production.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Iron (pig) [a]	24,035,034	$287,312,794	899,820	$11,464,635	24,934,854	$298,777,429
Manganese (spiegeleisen and ferromanganese)	75,751	1,422,039	122,888	4,604,353	198,639	6,026,392
Other ferro-alloys [b]	87,003	2,604,430	545	719,423	87,548	3,323,853
Nickel [c]			17,549.479	12,284,635	17,549.479	12,284,635
Aluminum [d]	39,565	14,522,700			39,565	14,522,700
Gold	156.788	94,531,800	30.008	18,093,023	186.796	112,624,823
Silver	2,484.176	40,067,700	1,364.199	22,003,388	3,848.375	62,071,038
Platinum and allied metals	.229	296,377	.882	1,092,327	1.111	1,388,704
Quicksilver	630.350	811,680			630.350	811,680
Tin [e]						
Copper, stated as refined	605,212	160,987,614	161,679	43,016,641	766,891	204,004,255
Lead, stated as refined	512,794	39,997,932	29,328	2,287,584	542,122	42,285,516
Antimonial lead	15,475	1,462,051	1,192	110,116	16,667	1,572,167
Zinc, stated as spelter	343,418	35,028,636	9,631	982,363	353,049	36,010,999
Total		679,045,753		116,658,488		795,704,191

[a] Marketed production.
[b] Includes marketed production of ferrosilicon, ferrophosphorus, ferrovanadium, ferrotungsten, ferromolybdenum, ferrotitanium. No ferrotitanium reported for 1914.
[c] Nickel content of imported matte and ore.
[d] Foreign included in domestic. Figures are consumption, not production.
[e] No report of any tin ore smelted other than experimentally.

Pig iron.—The marketed production of pig iron is usually reported by long tons. The output of 1911 was 23,257,288 tons, for 1912 it was 30,180,969 tons, for 1913 it was 30,388,935 tons, and for 1914 it was 22,263,263 tons.

Manganese (spiegeleisen and ferromanganese).—The figures for the important iron-manganese alloys were formerly published by the Survey combined with those of pig iron. Statistics for their total marketed production are now available separately. The marketed production for both alloys is given as 178,615 long tons in 1911, 227,939 tons in 1912, 226,475 tons in 1913, and 177,356 tons in 1914.

Ferrosilicon and ferrophosphorus.—The combined marketed production of ferrosilicon and ferrophosphorus was 70,122 long tons in 1911, 97,371 tons in 1912, 67,164 tons in 1913, and 77,182 tons in 1914.

Other ferro-alloys.—In addition to spiegeleisen, ferromanganese, ferrosilicon, and ferrophosphorus are the ferro-alloys known as ferromolybdenum, ferrotitanium (with 10 to 20 per cent of titanium), ferrovanadium, and ferrotungsten (with about 50 per cent of tungsten). The combined marketed output in 1911 was 4,638 long tons, in 1912 it was 3,375 tons, in 1913 it was 2,568 tons, and in 1914 it was 986 tons. No ferrotitanium was reported for 1914.

Nickel.—The nickel produced in the United States from domestic ores is merely a by-product from electrolytes of the copper refineries. A comparatively small output of nickel salts was recovered from domestic ores in 1912 and 1913, but the quantity is not known. The

figures for 1912, 1913, and 1914 given in the table represent the content of nickel in ore and matte "imported for consumption," mostly from the Canadian (Sudbury) deposits.

Aluminum.—There is only one producer of aluminum in the United States. The figures given are those for consumption and show 47,734,000 pounds for 1910, 46,125,000 pounds for 1911, 65,607,000 pounds for 1912, 72,379,000 pounds for 1913, and 79,129,000 pounds for 1914. The figures include the consumption of the imported metal as well as the domestic.

Gold and silver.—The production of gold and silver is usually given in fine ounces troy. The following table gives the output of domestic plants for 1913 and 1914:

Production of gold and silver in 1913 and 1914, in fine ounces troy.

	Domestic.	Foreign.[a]	Total.
Gold:			
1913	4,299,783	900,720	5,200,503
1914	4,572,976	875,250	5,448,226
Silver:			
1913	66,801,500	50,708,690	117,510,190
1914	72,455,100	39,789,129	112,244,229

[a] Foreign figures from United States Bureau of the Mint.

The unrefined foreign gold and silver come mainly from Canada, Mexico, Central America, and South America, and considerable ore from which gold and silver are by-products of the smelters in base bullion is also received by domestic plants, chiefly from these countries.

Platinum.—The production of platinum is usually reported in troy ounces, and the domestic output has been derived from crude platinum from gravels in Oregon and California, from copper-platinum-palladium ore from the Rambler mine in Wyoming, from gold-platinum-palladium ore from the Boss mine and adjoining properties in Clark County, Nev., and also as an additional source from refined metal recovered as a by-product in refining gold and copper bullion from domestic and foreign ores. The figures are 505 and 500 troy ounces, respectively, from domestic mines and refineries for 1912; 384 and 650 ounces, respectively, for 1913; and 778 and 5,869 ounces, respectively, for 1914. The quantity of refined platinum derived from ores and bullion entirely foreign amounted to 37,524 troy ounces in 1912, to 39,154 ounces in 1913, and to 25,758 ounces in 1914. An additional and large source of platinum is that recovered from dental and jewelry scrap.

Quicksilver.—The domestic production of quicksilver is entirely from domestic ores and is usually reported in flasks of 75 pounds each. The output was 21,256 flasks in 1911, 25,064 flasks in 1912, 20,213 flasks in 1913, and 16,548 flasks in 1914.

Tin.—The production of tin is usually given in short tons. About 50 tons of tin concentrates were produced in Alaska in 1914, and the estimated metallic content of the tin amounted to about 80,000 pounds. Nearly all the stream tin from Alaska is shipped to Singapore for smelting. The consumption in the United States is supplied largely by imports, but also by recoveries of secondary tin from alloys, drosses, and scrap tin plate.

Copper.—The production of domestic copper is usually reported as blister copper in pounds. The output of blister copper from domestic ores was 1,097,232,749 pounds in 1911, 1,243,268,720 pounds in 1912, 1,224,484,098 pounds in 1913, and 1,150,137,192 pounds in 1914. Foreign sources for copper produced and refined in the United States are Mexico, Canada, Peru, Europe, and other countries.

Lead.—The production of lead is usually given in short tons. The imports of foreign material for treatment in domestic plants come mainly from Mexico.

Antimonial lead.—The output of antimonial lead is mainly a metallurgical by-product obtained in refining lead bullion. The only domestic antimony recovered in 1913 and 1914 was derived from a small quantity of ore mined in Nevada in 1911, but the high prices at the end of 1914 caused the opening of old antimony mines and new prospects, and there will be a considerable output of antimony from domestic ores in 1915.

Zinc.—The production of metallic zinc or spelter is usually stated in short tons. The figures do not include zinc in pigments. Imports of foreign ores come mainly from Mexico.

ORES.

The following table shows the production of crude ores supplied from domestic mines to gold and silver mills, concentrating plants, and smelters:

Production of crude ores from domestic mines in 1911, 1912, 1913, and 1914, in short tons.

	1911	1912	1913	1914
Iron ores (marketed production)	46,023,540	63,859,728	66,800,270	44,479,994
Manganese ore	2,752	1,864	4,534	2,951
Manganiferous iron ore	3,006	3,247	10,808	65,390
Chromic iron ore	134	225	286	662
Tungsten ore	16,500	34,000	34,400	17,800
Titanium ore	.....	6,900	7,600	2,350
Aluminum ore	174,292	179,049	235,470	245,636
Gold ore	9,884,684	9,736,203	9,403,622	9,669,254
Silver ore	739,200	848,574	1,253,116	1,297,412
Quicksilver ore	138,525	155,693	136,278	122,998
Tin ore	42,200	3,000	7,500	16,600
Vanadium and uranium ore	8,468	18,000	27,900	[a] 24,500
Antimony ore	.....	.....	116	60
Copper ore:				
Western States	18,207,566	23,431,301	28,427,543	27,653,352
Central States	10,978,827	11,411,941	7,016,831	9,269,465
Eastern States	801,842	830,089	892,308	907,894
Total	29,988,235	35,673,331	36,336,682	37,830,711
Copper-lead ore	6,923	14,614	24,399	11,577
Lead ore:				
Western States	2,157,817	2,388,598	2,563,904	2,307,550
Central States	3,794,712	4,064,366	4,250,800	4,718,300
Total	5,952,529	6,452,964	6,814,704	7,025,850
Zinc and zinc-lead ore:				
Western States	1,356,781	1,344,222	1,658,486	2,117,558
Central States	10,629,269	11,899,185	10,767,340	9,747,210
Eastern States	413,332	497,832	692,348	901,184
Total	12,399,382	13,741,239	13,118,174	12,765,952
Grand total	105,380,370	130,728,622	134,215,858	113,579,697

[a] Estimated.

Iron ore.—Under iron ore are included 477,920 long tons of manganiferous iron ore (with low manganese content) in 1911, 816,984 tons in 1912, 612,743 tons in 1913, and 347,562 tons in 1914, shipped from Lake Superior mines. The Lake Superior and Clinton hematites are usually shipped without concentration, although there is a movement, now becoming important, to wash and concentrate some Lake ores, a detailed discussion of which is given in the report on iron ore in Mineral Resources for 1914. The eastern brown ores are usually washed to remove clay. The magnetites of New York are in part concentrated to remove apatite. All these ores are reported in the table as shipped or smelted.

Manganese ore.—High-grade manganese ore is produced mainly from Virginia, but the figures given include some output from California in 1911 and from California and South Carolina in 1912 and 1914 but not in 1913. Manganese ore is used principally for the manufacture of iron-manganese alloys as a flux in smelting, as an oxidizing and decolorizing agent, for making dry cells, and for coloring glass, brick, and pottery.

Manganiferous iron ore.—The low-grade manganiferous iron ores from the Lake Superior region are partly included with iron ores in the table. The remaining manganiferous iron ores come mainly from Arkansas and Virginia and are used chiefly in making high-manganese pig iron. Considerable quantities of manganiferous iron ores, usually argentiferous, are mined in Colorado and elsewhere and are used as fluxes in western lead smelters; they are included under ores of the precious metals.

Chromic iron ore.—Chromic iron ore or chromite is usually reported in long tons. The output, used as a pigment, in special tanning processes, for furnace linings, and in steel alloys, was 205 long tons in 1910, 120 tons in 1911, 201 tons in 1912, 255 tons in 1913, and 591 tons in 1914, all from California mines. The imports in 1912 were 53,929 long tons, in 1913 they were 65,180 tons, chiefly from Rhodesia, New Caledonia, and Russia, and in 1914 they were 79,842 tons, of which 25,970 tons came from New Caledonia, 30,000 tons from Portuguese Africa, and 14,830 tons from Asiatic Turkey.

Tungsten ore.—Tungsten ore is usually reported in short tons. The production stated in the table is in part estimated and includes the ore derived from the reworking of some hundreds of tons of old tailings. The ordinary commercial basis for tungsten ore in the United States is a content of 60 per cent tungsten trioxide. The production of tungsten in 1913 was 1,537 short tons, valued at $672,118, and in 1914 it was 990 tons, valued at $435,000. The metal is used chiefly for making high-speed steel and the filament of the tungsten incandescent electric lamp, although the total requirement for the latter purpose is small. The largest producers of tungsten ore were Colorado and California.

Vanadium ore.—The production of vanadiferous ores was confined to carnotite and roscoelite. The output of roscoelite could not be reported separately for 1910 or 1911, and is given combined with that of uranium ore (carnotite) in the tables for 1912, 1913, and 1914. The estimated quantity of vanadium ore produced in 1914 amounted to 24,500 short tons, containing 87 tons of uranium oxide, valued at $500,000. The ore is estimated to have contained 452 short tons of

recoverable vanadium, of unknown value, for a very low price was paid for vanadium in carnotite ore.

Titanium ore.—The domestic output of titanium ore has been mainly rutile from Virginia and amounted to 275 tons of rutile concentrates in both 1912 and 1913. In 1914 it amounted to 94 tons of concentrates containing 95 per cent titanium dioxide, and in addition, as a by-product, 89 tons of ilmenite carrying 55 per cent of titanium dioxide. Titanium is used chiefly for making ferrotitanium for steels and titanium carbide for electrodes, and this demand is in part supplied by the use of titaniferous magnetite and ilmenite, both of which are more plentiful and cheaper than rutile.

Aluminum ore.—The figures for aluminum ore given in the table represent domestic output of bauxite. In long tons, as usually reported, the production was 148,932 tons in 1910, 155,618 tons in 1911, 159,865 tons in 1912, 210,241 tons in 1913, and 219,318 tons in 1914. The output is derived mainly from Arkansas, Georgia, Alabama, and Tennessee. A possible new source of aluminum is alunite, deposits of which have recently been recognized and developed in Utah and elsewhere, attention being called to them mainly as a new source of potash. Bauxite is used chiefly as raw material in production of metallic aluminum and in the manufacture of aluminum salts, bauxite bricks, and alundum (an abrasive).

Gold ore.—The figures given for gold ore include siliceous, pyritic, and other ores in which the predominant value is for gold. The domestic gold output is derived not only from gold ore, but also from gravels of placer mines. Satisfactory figures for the quantity of gravels washed are not available, but it is hoped that they will be obtained by the Survey for future reports. A portion of the gold output is also derived from copper, lead, and mixed base-metal ores.

Silver ore.—The figures given for production of silver ore represent mainly silver-gold ores in which the value of the silver exceeds that of the gold. Of the total production in 1914, Nevada (mainly Tonopah) is credited with 676,573 short tons, New Mexico with 82,959 tons, Utah with 69,379 tons, Montana with 25,854 tons, Colorado with 271,509 tons, Texas with 40,375 tons, and Arizona with 128,759 tons. The Colorado output consists largely of iron-manganese-silver ores from Leadville, used as flux in the lead furnaces. Pure silver ore is rare. About two-thirds of the silver produced in the United States is derived as a by-product of lead and copper ores.

Quicksilver ore.—No quicksilver ore is imported. In 1912 the domestic output of ore treated included 139,347 short tons, averaging 0.55 per cent of metal, in California and 16,346 tons, averaging 1.04 per cent, in Texas and Nevada combined. In 1913 the production in California was 119,159 short tons, averaging 0.49 per cent of metal; in Nevada 8,755 tons, averaging 0.71 per cent; and in other States, including Texas, 8,461 tons, averaging 1.34 per cent. In 1914 the production in California was 101,553 short tons, averaging 0.41 per cent of metal; in Nevada 14,111 tons, averaging 0.56 per cent; and in other States, including Texas, 7,334 tons, averaging 1.62 per cent.

Copper ore.—The copper ore of the Western States is in part concentrated and in part smelted crude. The ores from Michigan are always concentrated, and those from Tennessee are smelted crude. The total quantity of copper concentrates from copper ore produced

in 1910 was 2,063,824 short tons, in 1911 it was 2,202,590 tons, in 1912 it was 2,734,065 tons, in 1913 it was 3,034,870 tons, and in 1914 it was 2,855,238 tons. The average percentage of copper in crude copper ore concentrated was 1.20, and the average percentage of copper in crude copper ore smelted was 4.23. A small part of the domestic output of copper is derived from gold, lead, zinc, and mixed ores.

Lead ore.—The lead ores of the Western and Central States are generally concentrated. The production of lead concentrates from the Central States, mainly from southeastern Missouri, was 260,967 short tons in 1910, 270,883 tons in 1911, 269,433 tons in 1912, 260,664 tons in 1913, and 294,124 tons in 1914. The output of lead concentrates in Idaho, the largest producer in the Western States in 1914, was 251,714 short tons, the production in Utah was 127,958 tons, and that in Colorado was 94,608 tons.

The largest producer of lead ore was Missouri, with 4,718,300 short tons, having an average recoverable lead content of 3.5 per cent. The average recoverable lead content of all lead ore was 5.7 per cent. The zinc-lead ores treated amounted to 1,544,659 tons, of which Idaho produced 668,430 tons, Montana 401,967 tons, and Utah 209,558 tons.

The following table shows the source of lead mined in the United States in 1914, by States, and kinds of ore, in short tons, and the recoverable lead content of each State for each kind of ore:

Source of mine production of lead in the United States in 1914, by States and kinds of ore, in short tons.

State.	Lead ores.			Lead-zinc ores.			Zinc ores.			All other ores.		Total.	
	Crude ore.	Recoverable lead content.	Percentage.	Crude ore.	Recoverable lead content.	Percentage.	Crude ore.	Recoverable lead content.	Percentage.	Crude ore.	Recoverable lead content.	Crude ore.	Lead content.
Arizona	26,687	4,827	18.1	23,444	1,947	8.5	18,079			7,941,717	728	8,009,927	7,502
Arkansas							20,000	41	0.2			20,000	41
California	16,820	2,123	14.4							2,448,665	3	2,465,485	2,126
Colorado	193,087	20,620	10.7	167,633	6,671	3.9	145,656	6		2,171,150	9,809	2,677,526	37,106
Idaho	1,421,893	130,845	9.2	668,430	43,411	6.5	8,473	5		136,553	2	2,235,349	174,263
Illinois							[a] 261,300	492	.2	(a)	225	261,300	717
Kansas							540,500	1,409	.3			540,500	1,409
Kentucky										(a)	16	(a)	16
Missouri	4,718,300	168,439	3.5				6,774,000	24,173	.4			11,492,300	192,612
Montana	29,636	1,940	6.5	401,967	2,822	.7	9,066			4,688,287	66	5,128,956	4,828
Nevada	16,088	1,714	10.7	16,075	1,862	11.6	9,490	81	.8	4,480,369	2,748	4,522,022	6,405
New Mexico	2,491	599	24.0	55,912	174	.4	(b)	46		2,174,450	63	2,232,853	882
Oklahoma							763,920	7,556	1.0			763,920	7,556
Oregon	57	6	10.5							124,274	2	124,331	8
South Dakota	7	2	28.5							2,019,255		2,019,262	2
Texas				1,640	74	4.5				40,630	1	42,270	75
Utah	600,481	73,187	12.1	209,558	11,930	5.1	4,670			7,729,305	545	8,544,014	85,662
Virginia							14,004	127	.9	1,440		15,444	127
Washington	303	32	10.6							95,644	1	95,947	33
Wisconsin							1,387,490	1,494	.1			1,387,490	1,494
Total	7,025,850	404,334	5.7	1,544,659	68,891	4.5	9,956,648	35,430	.4	34,051,739	14,209	52,578,896	522,864
Percentage of total lead derived from each kind of ore		77.3			13.2			6.8			2.7		100.0

[a] Tonnage of fluorspar from which lead was recovered as a by-product is excluded.

[b] Included in lead-zinc ores.

Zinc ore.—A considerable part of the zinc ore produced is used in the manufacture of pigments. Except some western ores, which are shipped crude, the zinc ores are generally concentrated. The zinc ore and concentrates of the Eastern States in 1914 were derived mainly from Franklin Furnace, N. J., but there was a largely increased output from eastern Tennessee and a small production from southwestern Virginia. The output from the Central States came chiefly from Missouri, Wisconsin, Oklahoma, Kansas, and Illinois, in the order named; and that from the Western States mainly from Montana, Colorado, Idaho, New Mexico, Utah, Nevada, Arizona, and Texas.

The largest producer of zinc concentrates in the Western States in 1914 was Montana, with 125,124 tons. The production from the Central States in 1914 was nearly 10,000 tons less than in 1913.

The following table shows the production of zinc concentrates in 1911, 1912, 1913, and 1914:

Production of concentrates of zinc in 1911, 1912, 1913, and 1914, in short tons.

	1911	1912	1913	1914
Western States	149,000	169,857	246,720	247,273
Central States	381,579	424,337	400,881	390,213
Eastern States	257,133	304,175	300,201	293,856

The average zinc assay of sphalerite concentrates from the Joplin region is more than 56.5 per cent, that of Montana sphalerite concentrates 44.54 per cent, that of Idaho sphalerite concentrates 40.84 per cent, and that of Colorado sphalerite concentrates 41.78 per cent.

In 1914 there were 10,908,164 tons of crude zinc ore treated, having a recoverable zinc content of 301,227 tons, and 1,488,747 tons of lead-zinc ore treated, having a recoverable zinc content of 104,054 tons.

The following table shows the mine production of zinc in 1914, by States and kinds of ore, in short tons:

Source of mine production of zinc in the United States in 1914, by States and kinds of ore, in short tons.

State.	Zinc ore.			Zinc-lead ore.			All other ore.		Total.	
	Crude ore.	Recoverable zinc content.	Percentage.	Crude ore.	Recoverable zinc content.	Percentage.	Crude ore.	Recoverable zinc content.	Crude ore.	Recoverable zinc content.
Arkansas	20,000	608	3.0						20,000	608
Arizona	18,079	2,322	12.8	23,444	2,574	10.9	7,968,404		8,009,927	4,896
California							2,465,485	195	2,465,485	195
Colorado	145,656	28,147	19.3	167,633	18,766	11.2	2,364,237	1,474	2,677,526	48,387
Idaho	8,473	3,280	38.6	668,430	17,726	2.6	1,558,446		2,235,349	21,006
Illinois	261,300	4,811	1.8						[a] 261,300	4,811
Kansas	540,500	11,284	2.1						540,500	11,284
Kentucky	[b] 8,400	230	2.7						8,400	230
Missouri	6,774,000	105,994	1.6				4,718,300		11,492,300	105,994
Montana	9,066	966	10.6	401,967	54,824	13.6	4,717,923		5,128,956	55,790
Nevada	9,490	2,919	30.8	16,075	3,571	22.2	4,496,457		4,522,022	6,490
New Hampshire	[b] 300	6	2.1						300	6
New Jersey	529,443	74,253	14.0						529,443	74,253
New Mexico	[c] 55,912	9,202	16.4				2,176,941		2,232,853	9,202
Oklahoma	763,920	13,992	1.8						763,920	13,992
Tennessee	357,437	10,425	2.9				653,621		1,011,058	10,425
Texas	24	9	37.5	1,640	99	6.0	40,606		42,270	108
Utah	4,670	1,492	31.9	209,558	6,494	3.1	8,329,786	9	8,544,014	7,995
Virginia	14,004	174	1.3				1,440		15,444	174
Wisconsin	1,387,490	31,113	2.2						1,387,490	31,113
Total	10,908,164	301,227	2.8	1,488,747	104,054	7.0	39,491,646	1,678	51,888,557	406,959
Percentage of total zinc derived from each kind of ore		74.0			25.6			0.4		100.0

[a] Exclusive of fluorspar ore mined in southern Illinois from which a small quantity of lead is recovered in milling.
[b] Estimated.
[c] Includes lead-zinc ore.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA IN 1914.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

In 1914 Arizona mines produced gold, silver, copper, lead, and zinc valued at $59,956,029, contained in bullion, ore of shipping grade, and concentrates. The value of the output when compared with that of 1913 decreased $10,918,998. There were 338 producers from deep mines and 57 producers from placers, as against 402 deep-mine and 36 placer producers in 1913, whose output was valued at $70,875,027. The decrease in total value of the metal output in 1914 was principally in copper, but also in lead and zinc, which decreased slightly. Gold increased in value from $4,023,911 in 1913 to $4,179,155, or $155,244, and silver from $2,384,647 to $2,421,031, or $36,384. The production of copper decreased in value from $63,228,127 in 1913 to $52,271,314, or $10,956,813, and of lead from $710,370 to $585,120, or $125,250. The output of zinc increased in quantity, but declined in value from $527,972 in 1913 to $499,409, or $28,563. The production of the metals since 1904, with increase or decrease for 1914, is given in the following table:

Number of producers, ore sold or treated in Arizona in 1904–1914, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	117	2,305,938	$3,478,532	2,314,940	199,481,044	1,779,967	.....	$29,816,840
1905	134	2,678,059	2,799,214	2,605,712	228,418,679	4,940,910	140,000	40,246,861
1906	171	3,585,089	2,964,683	3,026,438	266,831,864	5,638.735	.....	56,812,355
1907	437	3,567,133	2,617,313	2,511,897	254,879,489	4,660,684	228,490	55,511,560
1908	310	3,696,938	2,431,977	2,808,450	285,858,133	3,008,583	678,446	41,811,975
1909	268	4,029,955	2,737,500	2,601,161	303,899,461	3,098,083	5,977,237	44,053,023
1910	373	3,914,969	3,149,366	2,566,528	297,491,151	2,696,998	5,484,899	42,731,519
1911	397	4,567,139	3,430,503	3,276,571	306,141,538	10,274,552	4,562,984	44,157,223
1912	445	6,840,082	3,762,210	3,490,387	365,038,649	6,806,443	8,758,243	67,050,784
1913	438	7,931,862	4,023,911	3,948,091	407,923,402	16,144,772	9,428,067	70,875,027
1914	395	8,009,927	4,179,155	4,377.094	393,017,400	15,003,068	9,792,337	59,956,029
Increase (+) or decrease (−) in 1914		+78,065	+155.244	+429,903	−14,906,002	−1,141,704	+364,270	−10,918,998

[a] Includes placer production.

PRODUCTION OF ORE IN 1914.

Had the European war not occurred the output of ore from Arizona mines would have been the largest recorded, probably a third larger than as reported. As it was, the State is credited with 8,009,927 short tons in 1914 despite the curtailment, a quantity 78,065 tons larger than the output in 1913. The total average value per ton decreased from $8.93 in 1913 to $7.48 in 1914, but the gold and silver value increased from 80 cents to 82 cents a ton. The greatest increase was in the output of dry or siliceous ores, from 297,288 tons in 1913 to 428,805 tons in 1914. This classification includes 263,895 tons of siliceous gold ores, averaging $10.70 in gold and 1.31 ounces of silver per ton. These ores, including some reworked tailings in Yuma County, were principally from Mohave, Maricopa, Yavapai, and Pinal counties. Gold and silver ores, dry or siliceous in character, produced in various districts, aggregated 58 tons and averaged $16.67 in gold and 31.26 ounces of silver a ton. The siliceous silver ores produced in 1914 amounted to 128,759 tons, averaging per ton $1.32 in gold, 5.75 ounces of silver, 0.12 pound of copper, and 1.78 pounds of lead. These ores were produced chiefly in the Turquoise and Tombstone districts of Cochise County.

The copper ore, mined by 125 producers, amounted to 7,508,020 tons, against 7,553,935 tons mined by 280 producers in 1913. The copper ore mined in 1914 included the low-grade schist and "porphyry" copper ores at Ray and in the Globe district, where 3,616,952 tons were treated at concentration mills. Similar ores amounting to 1,515,988 tons were mined and milled for copper in Greenlee County, which embraces the Clifton and Morenci camps. Thus, the total output of schist and "porphyry" ores amounted to 5,132,940 tons, yielding 152,555,064 pounds of copper, or 38.8 per cent of the total output of copper. There were mined and smelted directly (without previous concentration) 2,135,614 tons of crude copper ores, averaging 46 cents in gold and 1.07 ounces of silver, and 5.41 per cent of copper, with a total value of $15.44 a ton, against nearly the same quantity in 1913, with an average value of $18.13 a ton. Of the copper ores smelted directly in 1914, a little over half, or 1,078,691 tons, were sulphides, averaging 49.6 cents in gold, 1.13 ounces of silver, and 5 per cent of copper, and having an average value of $14.44 a ton. The oxidized copper ore smelted contained 39.2 cents in gold, 1.03 ounces of silver, and 5.83 per cent of copper, and was valued at $16.47 a ton. Very little decrease was made in lead ores smelted, which amounted to 26,015 tons in 1914, against 26,203 tons in 1913. The larger part, or 24,045 tons, were sulphides and 1,970 tons were oxidized ores. The former contained $1.61 in gold, 14.06 ounces of silver, 0.83 per cent of copper, and 18.62 per cent of lead, and had a total average value of $26.12 a ton. The quantity of zinc ores mined increased from 14,554 tons in 1913 to 18,079 tons in 1914. Of this ore, 838 tons were sulphides shipped crude to smelters, along with 54 tons of oxidized ore. The remainder of the zinc ore, 17,187 tons, was concentrated and yielded 5,729 tons of concentrate. The lead-zinc ores amounted to 23,444 tons, of which 415 tons, mostly sulphides, were shipped to the smelters and 23,029 tons were concentrated and yielded 12,909 tons of concentrate. The copper-lead ore,

4,892 tons in quantity, was mostly oxidized, there being only 31 tons classified as sulphides. The oxidized ore contained 45 cents in gold, 6.47 ounces of silver, 3.22 per cent of copper, and 7.84 per cent of lead, and had an average value of $18.71 a ton. The total quantity of crude ore mined and sold or treated in Arizona in 1914 is shown in the following table:

Output of ore and production of metals in Arizona in 1914, by kinds of ore.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	57	.....	1,458.02	241	.....	.....	.....
Dry or siliceous ore	145	428,805	145,255.71	1,133,976	1,210,305	679,549	.....
Copper ore	125	7,508,020	50,842.80	2,604,371	391,020,335	6,024	.....
Lead ore	61	26,687	2,188.48	493,226	451,504	9,653,839	.....
Zinc ore	3	18,079	1,570.45	34,691	582	951	4,644,952
Copper-lead ore	10	4,892	108.75	31,991	316,684	769,586	.....
Lead-zinc ore	6	23,444	742.41	79,498	17,990	3,893,119	5,147,385
Total	.....	8,009,927	202,166.62	4,377,994	393,017,400	15,003,068	9,792,337

Subdivision of ore sold or treated in Arizona in 1914, by counties and by kinds, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	164,453	1,406,439	24,214	35	52	192	1,595,385
Coconino	.....	63	.....	.....	.....	.....	63
Gila	28	1,513,721	51	.....	.....	.....	1,513,800
Graham	.....	56	.....	.....	.....	.....	56
Greenlee	489	1,683,992	.....	.....	.....	.....	1,684,481
Maricopa	39,394	46	.....	.....	.....	.....	39,440
Mohave	161,584	1,999	315	18,025	.....	22,081	204,004
Pima	37	4,801	91	.....	4,728	.....	9,657
Pinal	4,404	2,458,018	36	.....	1	.....	2,462,459
Santa Cruz	199	10,199	1,124	19	111	1,171	12,823
Yavapai	31,493	428,164	325	.....	.....	.....	459,982
Yuma	26,724	522	531	.....	.....	.....	27,777
Total	[a] 428,805	7,508,020	26,687	18,079	4,892	23,444	8,009,927
Value per ton in gold and silver	$8.46	$0.33	$11.92	$2.86	$4.08	$2.53	$0.82

[a] Includes 263,895 tons of gold ore, 58 tons of gold and silver ore, 128,759 tons of silver ore, and 36,093 tons of iron ore.

GOLD.

The mine production of gold contained in Arizona ores and placer dust and bullion in 1914 amounted to 202,166.62 ounces, valued at $4,179,155. Of this value $30,140 came from placers, $3,002,702 against $2,558,426 in 1913 from dry or siliceous ore, and $1,051,014 against $1,332,038 in 1913 from copper ores. The mines of Mohave County produced the largest amount of gold, $1,891,214 in 1914, against $1,874,547 in 1913 and $1,899,131 in 1912. The Tom Reed and Gold Road mines were the largest contributors. Gold from ores treated in mills by amalgamation amounted to $259,063 and from ores treated by cyanidation to $2,157,080. Concentrates contained $318,166, as against $308,090 in 1913, and ores shipped directly to smelters contained $1,410,606, against $1,362,504 in 1913. The chief

producing districts in 1914 were the San Francisco district in Mohave County, where siliceous ores were produced, and the Warren or Bisbee district in Cochise County, where copper ores were produced.

A gold strike about 4½ miles north of Ray during 1914 created some local excitement. The find was made in Gold Creek gulch, which has its mouth on the east side of Mineral Creek. There are several strong veins[1] traversing the country, some lying in schist and some on the contact between schist and diabase. Croppings of these veins contain an excellent showing of native gold visible to the naked eye, and at many points on the vein colors of gold can be obtained by panning. About 50 mining claims were located and prospecting was quite active during the greater part of the year on possibly a dozen of the claims, but no reports were received by the Survey of any extensive production.

The Congress district is reported[2] to be active again, but under different conditions.

This district attracted attention in former years on account of the richness and persistence of the Congress lode. Much excitement was caused in the early days by the finding of considerable quantities of native gold on the tops of the hills. Although for many years these deposits furnished ground for "dry washing," the persistent work of Messrs. Genung and Barnum in tracing the source of these dry placers has led to the uncovering of the old topography and the discovery of the ancient channel. Three hundred linear feet of exploration on this "deep lead" has demonstrated that it is the source of the "nuggets."

Source of mine production of gold in Arizona, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	10.98	8,813.88	38,346.37	1,906.36	2.47	1.55	3.29	49,084.90
Coconino			.24					.24
Gila	7.01	16.69	2,121.78	8.90				2,154.38
Graham			.05					.05
Greenlee	109.72	167.29	692.67					969.68
Maricopa	75.46	26,022.13	1.35					26,098.94
Mohave		89,048.85	85.09	46.44	1,567.98		739.12	91,487.48
Pima	359.09	42.42	43.15	11.42		19.30		475.38
Pinal	24.33	1,985.08	862.61	.97		.05		2,873.04
Santa Cruz	14.85	114.75	18.00	82.32		87.85		317.77
Yavapai	589.69	17,646.84	8,604.73	106.71				26,947.97
Yuma	266.89	1,397.78	66.76	25.36				1,756.79
Total	1,458.02	[a]145,255.71	50,842.80	2,188.48	1,570.45	108.75	742.41	202,166.62

[a] Includes 136,558.47 ounces from gold ore, 46.78 ounces from gold and silver ore, 8,230.65 ounces from silver ore, and 419.81 ounces from iron ore.

SILVER.

The mine output of silver in Arizona increased from 3,948,091 ounces, valued at $2,384,647, in 1913, to 4,377,994 ounces, valued at $2,421,031, in 1914. Of this output, 2,604,371 ounces came from copper ore, 1,133,976 ounces from dry or siliceous ore, 493,226 ounces from lead ore, and smaller quantities from lead-zinc, zinc, and copper-lead ores. The greatest increase of silver originated in the siliceous ore,

[1] Cates, L. S., Ray, Ariz., discovery described in personal communication dated Feb. 19, 1914.

[2] Willis, C. F., director Arizona State Bur. Mines, Min. and Sci. Press, Aug. 14, 1915, p. 246.

produced mainly from the Commonwealth mine in the Turquoise district of Cochise County between May and August, 1914. Bullion recovered from gold and silver ores, principally by cyanidation, yielded 617,049 ounces of silver in 1914. Concentrates contained 423,982 ounces and crude ore shipped to smelters contained 3,280,667 ounces. Cochise County mines led in production of silver, producing 2,753,953 ounces of silver in 1914, against 2,127,191 ounces in 1913 and 1,962,644 ounces in 1912. Yavapai County produced 786,917 ounces of silver in 1914, against 854,049 ounces in 1913.

Source of mine production of silver in Arizona, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	2	774,135	1,636,610	339,593	277	672	2,664	2,753,953
Coconino	.....	.....	145	.....	.....	.....	.....	145
Gila	2	267	272,267	371	.....	.....	.....	272,907
Graham	.....	.....	203	.....	.....	.....	.....	203
Greenlee	22	9,185	2,504	.....	.....	.....	.....	11,711
Maricopa	7	17,061	892	.....	.....	.....	.....	17,960
Mohave	.....	43,141	5,628	12,914	34,414	.....	74,748	170,845
Pima	69	549	14,951	2,503	.....	28,710	.....	46,782
Pinal	5	1,119	175,679	1,207	.....	392	.....	178,402
Santa Cruz	2	1,755	12,751	109,459	.....	2,217	2,086	128,270
Yavapai	87	283,275	479,899	23,656	.....	.....	.....	786,917
Yuma	45	3,489	2,842	3,523	.....	.....	.....	9,899
Total	241	[a] 1,133,976	2,604,371	493,226	34,691	31,991	79,498	4,377,994

[a] Includes 345,203 ounces from gold ores, 1,813 ounces from gold and silver ore, 740,007 ounces from silver ore, and 46,953 ounces from iron ore.

COPPER.

Market conditions resulting from the European war lessened the output of copper in Arizona from 407,923,402 pounds, valued at $63,228,127, in 1913, to 393,017,400 pounds, valued at $52,271,314, in 1914. Notwithstanding this decrease, Arizona continued to be the leading copper-producing State. Crude ore shipped directly to the smelters yielded the largest quantity, or 233,047,975 pounds of copper, against 255,867,509 pounds in 1913. Of the output in 1914 Cochise County produced 66 per cent of the State total from crude ores smelted. Yavapai, Gila, and Greenlee counties also produced large quantities. The copper in concentrates produced at milling plants increased from 147,327,295 pounds in 1913 to 158,985,306 pounds in 1914. This increase was due principally to greater output in Pinal, Gila, and Yavapai counties. Gila County, including the Globe and Miami districts, produced altogether 73,488,162 pounds, against 71,609,847 pounds in 1913, 63,969,423 pounds in 1912, and 49,226,341 pounds in 1911. The low-grade schist and so-called "porphyry" ores in Pinal and Gila counties yielded 95,485,293 pounds of copper, against 87,073,406 pounds in 1913, 68,753,553 pounds in 1912, and 30,666,515 pounds in 1911. Similar low-grade copper deposits exist in Greenlee County, whose output added made the total production from the so-called "porphyries" in Arizona 152,555,064 pounds, or 38.82 per cent of Arizona's copper output in 1914. In 1913 these ores altogether produced 138,471,483 pounds of copper. The activity of three large operators of copper mines in the Catalinas, Ajo, and Silver

Bell districts has caused renewed attention to possible low-grade disseminated copper deposits in other districts.

Source of mine production of copper in Arizona, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	616,909	154,393,026	403,940	582	3,206	3,224	155,420,887
Coconino	.....	19,672	.....	.....	.....	.....	19,672
Gila	259	73,487,845	58	.....	.....	.....	73,488,162
Graham	.....	11,838	.....	.....	.....	.....	11,838
Greenlee	118	65,558,383	.....	.....	.....	.....	65,558,501
Maricopa	33,440	6,143	.....	.....	.....	.....	39,583
Mohave	300	748,036	361	.....	.....	11,981	760,678
Pima	255	608,644	2,244	.....	301,509	.....	912,652
Pinal	758	60,289,596	54	.....	228	.....	60,290,636
Santa Cruz	867	2,279,776	42,311	.....	11,741	2,785	2,337,480
Yavapai	557,392	33,498,727	1,833	.....	.....	.....	34,057,952
Yuma	7	118,649	703	.....	.....	.....	119,359
Total	[a] 1,210,305	391,020,335	451,504	582	316,684	17,990	393,017,400

[a] Includes 592,784 pounds from gold ore, 15,136 pounds from silver ore, and 602,385 pounds from iron ore.

LEAD.

In 1914 the mine output of lead in Arizona was 15,003,068 pounds, valued at $585,120, against 16,144,772 pounds, valued at $710,370, in 1913, and 6,806,443 pounds in 1912. Cochise County, principally the Warren or Bisbee district, had the largest yield of lead, or 9,331,116 pounds, valued at $363,914, as against 7,844,204 pounds, valued at $345,145, in 1913. Mohave County followed with 3,718,057 pounds, Pima County with 769,145 pounds, and Santa Cruz County with 403,272 pounds. Concentrates derived from low-grade ores produced 4,306,977 pounds of lead, and crude ores shipped directly to smelters produced 10,696,091 pounds.

Source of mine production of lead in Arizona, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Cochise	232,319	1,046	9,051,817	951	16,134	28,849	9,331,116
Gila	117	82	21,376	.....	.....	.....	21,575
Maricopa	371,468	.....	.....	.....	.....	.....	371,468
Mohave	3,947	.....	56,808	.....	.....	3,657,302	3,718,057
Pima	647	2,306	37,405	.....	728,787	.....	769,145
Pinal	.....	.....	32,415	.....	819	.....	33,234
Santa Cruz	.....	2,590	169,868	.....	23,846	206,968	403,272
Yavapai	71,051	.....	98,908	.....	.....	.....	169,959
Yuma	.....	.....	185,242	.....	.....	.....	185,242
Total	[a] 679,549	6,024	9,653,839	951	769,586	3,893,119	15,003,068

[a] Includes 449,773 pounds from gold ore and 229,776 pounds from silver ore.

ZINC.

The mine output of zinc (calculated as spelter) from American zinc-bearing ores in 1914 amounted to 9,792,337 pounds, valued at $499,409, against 9,428,067 pounds, valued at $527,972, in 1913, and 8,758,243

pounds in 1912. Most of the zinc ore was mined in Mohave County at Union Pass and Chloride, was shipped in the form of concentrates to the smelters, and yielded 8,933,760 pounds of zinc. A very small quantity of zinc ore was mined in 1914 in Cochise and Santa Cruz counties. No zinc ore was produced in Pima County in 1914, but in 1913 there was a production of 2,127,568 pounds of zinc.

Source of mine production of zinc (spelter) in Arizona, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Cochise	13,566	108,738	122,304
Mohave	4,620,942	4,932,108	9,553,050
Santa Cruz	10,444	106,539	116,983
Total	4,644,952	5,147,385	9,792,337

Zinc ore and concentrate produced from Arizona mines and mills, sold in 1914, by source and by counties.

County.	Classification.	Quantity.	Average assay of ore and concentrate.[a]
		Short tons.	*Per cent of zinc.*
Cochise, Mohave, and Santa Cruz	Sulphide zinc ore	1,231	38.00
Cochise and Santa Cruz	Carbonate ore	76	38.82
Cochise, Mohave, and Santa Cruz	Concentrates (sulphide)	12,984	40.50
Total ore and concentrates		14,291	40.32

[a] Actual assay content.

MINING INDUSTRY IN 1914.

The copper industry was the first to be affected in Arizona by conditions resulting from the beginning of the European war. It was found imperative to make a reduction of working forces. Married men who had families were generally retained at their work at the mines. At Bisbee about 500 men, or about a quarter of the working force, were laid off, and altogether about 2,000 men in the Bisbee camp and vicinity were affected by a cut in wages. Similar reductions were made in all other mining districts, and at Ray the working force was put on half time. However, these conditions did not prevail in the gold camps, where production and favorable developments in new enterprises nearly approached a boom and required an increase in the working force. The San Francisco district, in Mohave County, in the vicinity of Oatman, where the Tom Reed and the Gold Road properties are situated, was active, and earlier in the year some attention was given to new gold finds in Gold Creek gulch, about 4½ miles north of Ray.

Construction work was completed in 1914 on the Verde Tunnel & Smelter Railroad to connect Clarkdale with another standard-gage road, 39 miles long, built to a junction with the Santa Fe

system at Cedar Glade, Ariz., displacing the old narrow-gage road at Jerome, in Yavapai County. At the close of the year two new railroad branches had material on the ground to begin construction. One line is to connect the Magma mine at Superior with the railroad at Webster, a new station near Florence on the Arizona & Eastern Railroad. This narrow-gage railroad will be 28 miles long and will overcome the wagon haul which the Superior district has had to contend with for years. It is anticipated that this railroad will stimulate mining in the region. Another railroad, 15 miles long, to be built, and for which material is already delivered, is the Mascot & Western, connecting the property of the Mascot Copper Co., in the Dos Cabezas district of Cochise County, with the Southern Pacific Railroad at Willcox. Transportation is said to be all that the region has been needing to make it prominent among the producing mining districts of the State. Several years ago the Mascot copper property, consisting of about 800 acres of mineralized ground in the heart of the Dos Cabezas district, was very actively developed and considerable work has been reported from year to year. Preliminary surveys have been made for another railroad branch connecting Ajo with Gila, on the Southern Pacific and El Paso & Southwestern systems. The distance to Gila is about 44 miles and to Tucson about 130 miles.

REDUCTION MILLS.

Milling plants of various kinds to the number of 49 were in operation in Arizona during 1914. Not all of these plants were in continuous operation. Eight mills used straight amalgamation; 10, amalgamation and concentration; 3, amalgamation and cyanidation; 9, only cyanidation; 18, straight concentration; and 1, amalgamation, concentration, and cyanidation combined. Two plants, each housing the three processes under one roof, were being constructed. Only one of the concentration plants had begun to use the flotation process, and tests were being made at a number of other plants. A list giving all the mills in commission, including many new plants under construction in 1911 and some in 1912, is given in Mineral Resources for 1911.

In 1914 the ore treated by amalgamation amounted to 44,808 tons and produced 12,532.15 ounces of gold and 3,014 ounces of silver, an average recovery per ton of $5.78 in gold and 0.07 ounce of silver. Ores treated by cyanidation amounted to 267,945 tons, which, with 26,882 tons of old tailings, produced 104,348.75 ounces of gold and 614,035 ounces of silver, or an average recovery per ton for ore and tailings of $7.32 in gold and 2.08 ounces of silver. The total value of the bullion recovered from ore and tailings was $2,757,371, as against $2,353,855 in 1913. During 1914 there were 1,802 pounds of quicksilver, 12,040 pounds of potassium cyanide, and 252,929 pounds of sodium cyanide consumed at milling plants. This corresponds to 0.116 pound of mercury per ounce of gold and silver and 0.04 pound of mercury per ton of ore treated. The consumption of cyanide was 0.369 pound per ounce of gold and silver and 0.90 pound per ton of ore and tailings treated.

Ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Arizona in 1914, by counties.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine oz.*	*Fine oz.*	*Fine oz.*	*Fine oz.*	
Cochise	104,174	239.00	60	6,546.43	564,798	$452,633
Gila	8	7.00	2	.....	.....	146
Maricopa	38,933	9,764.14	2,308	[a] 7,526.02	[a] 4,565	361,220
Mohave	161,270	67.99	39	[b] 88,569.17	[b] 41,165	1,855,079
Pima	20	16.58	9	.....	.....	348
Pinal	4,336	1,461.48	342	476.00	80	40,284
Santa Cruz	120	41.11	21	.....	.....	862
Yavapai	3,372	764.45	189	[c] 168.24	[c] 26	19,400
Yuma	520	170.40	44	[d] 1,062.89	[d] 3,401	27,399
Total	312,753	12,532.15	3,014	104,348.75	614,035	2,757,371

[a] Includes bullion from 412 tons of old tailings.
[b] Includes bullion from 200 tons of old tailings.
[c] Includes bullion from 150 tons of old tailings.
[d] Includes bullion from 26,120 tons of old tailings.

Concentration plants reduced 5,384,083 tons of ore to 460,338 tons of concentrates, which were shipped to smelters and yielded $318,166 in gold, 423,982 ounces of silver, 158,985,306 pounds of copper (or more than 40 per cent of the total output of copper in the State), 4,306,977 pounds of lead, and 8,950,424 pounds of zinc (spelter), valued in all at $22,322,118, a total average per ton of $48.49. Copper concentrates amounting to 440,161 tons comprised nearly 96 per cent of the total concentrates produced. The two following tables give the quantity of ore concentrated and of the concentrates with their metallic content by counties; also the production by kinds of concentrate and the averages for 1911, 1912. 1913, and 1914:

Mine production of gold, silver, copper, lead, and zinc from Arizona concentrates in 1914.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine oz.*	*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	3,219	730	3.51	405	88,711	3,245	10,730	$12,770
Gila	1,334,907	93,531	1,469.00	141,462	47,748,598	.....	.....	6,459,160
Greenlee	1,513,865	178,988	152.00	200	49,964,102	.....	.....	6,648,479
Maricopa	.....	1,150	8,664.56	10,153	33,311	371,468	.....	203,645
Mohave	35,188	18,473	2,347.78	107,084	11,987	3,668,942	8,933,760	708,054
Pima	.....	1	3.26	438	31	424	.....	329
Pinal	2,448,628	154,377	680.55	115,999	58,217,836	.....	.....	7,821,187
Santa Cruz	880	240	11.00	2,099	2,785	129,782	5,934	7,122
Yavapai	46,996	12,813	2,059.45	44,789	2,917,945	84,452	.....	458,722
Yuma	400	35	.19	1,353	.....	48,664	.....	2,650
Total	5,384,083	460,338	15,391.30	423,982	158,985,306	4,306,977	8,950,424	22,322,118

By kinds of concentrates.

Dry or siliceous	168	584.98	1,003	1,009	4,000	.....	12,937
Copper	440,161	3,716.06	298,722	158,932,432	.....	.....	21,380,025
Lead	7,010	9,655.89	89,406	50,340	4,221,169	.....	420,367
Zinc	12,951	1,427.68	34,033	.....	64,508	8,933,760	506,471
Copper-lead	15	6.18	119	1,242	3,443	.....	493
Lead-zinc	33	.51	699	283	13,857	16,664	1,825

Kinds of concentrate and average metallic content of each kind produced in Arizona in 1911–1914.

Kind of concentrate and source of production.	Concentrate.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Gold and silver mills—							
1911	1,885	$60.52	8.92	0.98	.....	.....	$67.71
1912	772	135.15	6.89	.79	7.91	.....	149.38
1913	66	72.41	42.41	.34	.....	.....	103.11
1914	165	72.47	5.38	.30	1.21	.....	77.20
Concentration mills—							
1911	837	13.75	130.17	.39	1.87	.....	85.42
1912	814	25.52	140.25	1.32	4.52	.....	119.95
1913	150	19.32	21.58	1.68	.....	.....	35.84
1914	3	44.67	38.67	.....	.....	.....	66.00
Copper:							
Concentration mills—							
1911	304,123	.11	.60	15.64	.....	.....	39.52
1912	400,134	.06	.46	16.93	.....	.....	56.22
1913	435,389	.22	.55	16.91	.....	.....	52.98
1914	440,161	.17	.68	18.05	.....	.....	48.57
Lead:							
Concentration mills—							
1911	3,467	8.68	12.68	.21	33.33	.....	45.93
1912	88	63.34	68.50	.05	6.53	.....	111.52
1913	8,892	4.60	13.56	.13	27.82	.....	37.68
1914	5,757	2.60	13.21	.13	32.91	.....	35.92
Gold and silver mills—							
1913	1,042	143.10	8.02	1.30	16.58	.....	166.57
1914	1,253	147.36	10.65	1.40	17.25	.....	170.44
Zinc:							
Concentration mills—							
1911	4,045	4.91	7.36	.06	1.77	38.13	54.02
1912	7,524	5.51	7.37	.81	2.48	31.75	58.76
1913	8,848	1.40	1.98	.05	.55	34.79	42.19
1914	12,951	2.28	2.63	.....	.02	34.49	39.10
Copper-lead:							
Concentration mills—							
1913	6	41.33	135.00	7.00	18.00	.....	160.33
1914	15	8.53	7.93	4.14	11.48	.....	32.86
Lead-zinc:							
Concentration mills—							
1911	39	25.21	20.51	1.13	30.09	11.43	79.00
1912	2,295	6.72	10.28	.96	25.05	17.06	59.45
1914	33	.30	21.18	.04	21.00	25.25	55.30

Of the material smelted the crude ore was the largest part—2,238,808 tons—and contained the following quantities of recoverable metals: 68,238.06 ounces, or $1,410,606 in gold; 3,280,667 ounces of silver, 233,047,975 pounds of copper, 10,696,091 pounds of lead, and 841,913 pounds of zinc, valued in all at $34,680,281, or an average value per ton of $15.49. Of the crude ores smelted the copper ores constituted the largest part—2,135,614 tons, of which the Warren or Bisbee district in Cochise County produced 63.67 per cent. The dry or siliceous ores formed the next largest quantity—70,980 tons, followed by lead ores—26,015 tons, the latter being produced largely in the Warren or Bisbee district of Cochise County.

Mine production of gold, silver, copper, lead, and zinc from Arizona crude ore shipped to smelters in 1914.

By counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	1,454,553	42,086.64	2,132,767	154,762,578	9,327,871	111,574	$23,002,328
Coconino	63	.24	145	19,672	.....	.....	2,701
Gila	178,068	671.37	131,441	25,701,238	21,575	.....	3,505,671
Graham	56	.05	203	11,838	.....	.....	1,687
Greenlee	161,713	707.96	11,489	15,220,479	.....	.....	2,045,312
Maricopa	95	68.76	927	6,272	.....	.....	2,768
Mohave	3,106	592.54	22,557	748,691	49,115	619,290	155,939
Pima	9,637	96.45	46,266	912,621	768,721	.....	178,938
Pinal	9,493	230.68	61,842	2,070,525	33,234	.....	315,644
Santa Cruz	11,823	250.81	126,148	2,334,695	273,490	111,049	401,788
Yavapai	409,464	23,366.14	741,826	31,140,007	85,507	.....	5,038,206
Yuma	737	256.42	5,056	119,359	136,578	.....	29,299
Total	2,238,808	68,238.06	3,280,667	233,047,975	10,696,091	841,913	34,680,281

By kinds of ore.

Dry or siliceous	70,980	18,663.76	448,955	1,172,934	239,755	.....	$799,437
Copper	2,135,614	47,115.73	2,303,101	231,103,784	6,024	.....	32,984,622
Lead	26,015	2,154.61	489,450	451,050	9,576,985	.....	748,698
Zinc	892	192.45	4,792	582	951	643,300	39,551
Copper-lead	4,892	108.73	31,991	316,684	769,586	.....	92,072
Lead-zinc	415	2.78	2,378	2,941	102,790	198,613	15,901

Crude ore, by kinds, and average metallic content of each kind produced in Arizona and shipped to smelters in 1911–1914.

Kind of crude ore.	Ore.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	48,037	$1.63	4.49	0.68	0.01	.....	$5.71
1912	7,276	10.02	19.70	.37	.14	.....	23.48
1913	61,395	1.39	3.83	.77	.27	.....	6.33
1914	70,980	5.44	6.33	.83	.17	.....	11.26
Copper:							
1911	1,655,989	.62	1.18	6.30	.....	.....	17.01
1912	2,106,929	.55	1.04	5.31	.....	.....	18.72
1913	2,327,438	.53	1.13	5.46	.....	.....	18.13
1914	2,135,614	.46	1.07	5.41	.....	.....	15.44
Lead:							
1911	21,190	6.45	29.69	.63	17.61	.....	39.63
1912	20,696	6.09	28.66	.18	10.98	.....	34.18
1913	26,203	1.35	18.48	1.19	17.91	.....	31.97
1914	26,015	1.71	18.81	.87	18.41	.....	28.78
Zinc:							
1911	2,106	4.31	8.09	.04	2.57	34.89	50.79
1912	4,264	5.43	7.51	.94	2.40	33.76	61.96
1913	5,878	.95	1.55	.02	.47	26.84	32.42
1914	892	4.46	5.37	.03	.05	32.06	44.34
Copper-lead:							
1911	129	2.08	39.55	4.11	39.38	.....	68.76
1912	315	5.51	59.30	4.24	18.21	.....	72.38
1913	4,834	1.41	6.94	3.23	9.28	.....	23.77
1914	4,892	.46	6.54	3.24	7.87	.....	18.82
Lead-zinc:							
1912	528	.74	17.61	.64	15.93	30.14	69.61
1913	214	.85	22.39	.88	16.85	27.39	62.61
1914	415	.14	5.73	.35	12.38	23.93	38.32

SMELTING IN ARIZONA IN 1914.

Smelter construction in Arizona during 1914 was very active. At Miami the International Smelting Co. was erecting a plant designed principally for reducing the copper concentrates of that district, and at Clarkdale the United Verde Copper Co. was completing a new plant, which is described in this report under the Verde district in Yavapai County. A brief description is also given of the Hayden plant under the Mineral Creek district in Pinal County. Nine copper smelting plants were in operation and two plants were under construction in Arizona in 1914. A table giving the list of smelters in Arizona was published in Mineral Resources for 1913, Part I, page 681. The list is complete, except that it omits the name of the International smelter. In 1914 the Swansea and Pioneer smelters were idle.

A classification by kinds of crude ore smelted, separated into oxidized and sulphide ores, with average content, is shown in the following two tables:

Oxidized and sulphide crude ore, by kinds, including mixed dry ores and carbonate ores, produced in Arizona, and shipped to smelters in 1914.

Kind of ore.	Ore.	Metal content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	70,980	18,663.76	448,955	1,172,934	239,755	.....	$799,437
Copper:							
Oxidized	1,056,923	20,277.11	1,084,403	123,250,660	6,024	.....	17,411,413
Sulphide	1,078,691	26,838.62	1,218,698	107,853,124	.....	.....	15,573,209
Lead:							
Oxidized	1,970	267.91	151,331	50,889	630,904	.....	120,597
Sulphide	24,045	1,886.70	338,119	400,161	8,946,081	.....	628,101
Zinc:							
Oxidized	54	2.45	277	582	951	24,010	1,542
Sulphide	838	190.00	4,515	.....	.....	619,290	38,009
Copper-lead:							
Oxidized	4,861	105.10	31,442	313,208	762,589	.....	90,959
Sulphide	31	3.63	549	3,476	6,997	.....	1,113
Lead-zinc:							
Oxidized	22	.78	194	.....	4,113	25,758	1,598
Sulphide	393	2.00	2,184	2,941	98,677	172,855	14,303
Total	2,238,808	68,238.06	3,280,667	233,047,975	10,696,091	841,913	34,680,281

Oxidized and sulphide ore, average metallic content, by kinds, produced in Arizona and shipped to smelters in 1913–14.

Kind of ore.	Ore.	Average metallic content.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
Dry or siliceous:	*Short tons.*	*Fine oz. per ton.*	*Fine oz. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1913	61,395	0.07	3.83	0.77	0.27	.....	$6.33
1914	70,980	.26	6.33	.83	.17	.....	11.26
Copper:							
Oxidized—							
1913	1,144,459	.02	.97	5.54	.....	.....	18.09
1914	1,056,923	.02	1.03	5.83	.....	.....	16.47
Sulphide—							
1913	1,182,979	.03	1.29	5.38	.....	.....	18.16
1914	1,078,691	.02	1.13	5.00	.....	.....	14.44

Oxidized and sulphide ore, average metallic content, by kinds, produced in Arizona and shipped to smelters in 1913–14—Continued.

Kind of ore.	Ore.	Average metallic content.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
Lead:							
Oxidized—	*Short tons.*	*Fine oz. per ton.*	*Fine oz. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1913	6,228	0.04	15.69	2.72	18.14	.....	$34.75
1914	1,970	.14	76.82	1.29	16.01	.....	61.21
Sulphide—							
1913	19,975	.07	19.35	.71	17.84	.....	31.11
1914	24,045	.08	14.06	.83	18.62	.....	26.12
Zinc:							
Oxidized—							
1913	4,413	.....	.....	.02	.....	24.34	27.33
1914	54	.05	5.13	.54	.88	22.23	28.55
Sulphide—							
1913	1,465	.18	6.21	.03	1.87	34.34	47.76
1914	838	.23	5.39	.....	.....	36.95	45.36
Copper-lead:							
Oxidized—							
1913	4,699	.06	5.89	3.13	9.20	.....	22.62
1914	4,861	.02	6.47	3.22	7.84	.....	18.71
Sulphide—							
1913	135	.32	43.53	6.44	12.23	.....	63.75
1914	31	.12	17.71	5.61	11.29	.....	35.90
Lead-zinc:							
Oxidized—							
1914	22	.04	8.82	.....	9.35	58.54	72.64
Sulphide—							
1913	214	.04	22.39	.88	16.85	27.39	62.61
1914	393	.01	5.56	.37	12.55	21.99	36.39
Total—1913	2,425,962	.03	1.40	5.27	.22	.07	18.03
1914	2,238,808	.03	1.47	5.20	.24	.02	15.49

Arizona's output of metals, by counties, is shown in the following tables, which give the metallic output of each county, and the total value for 1914, and also the output of ore and the average values per ton compared for 1913 and 1914:

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1914, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine oz.		*Fine oz.*			*Fine oz.*	
Cochise	10.98	$227	49,073.92	$1,014,448	$1,014,675	2,753,953	$1,522,936
Coconino	.....	.....	.24	5	5	145	80
Gila	7.01	145	2,147.37	44,390	44,535	272,907	150,917
Graham	.....	.....	.05	1	1	203	112
Greenlee	109.72	2,268	859.96	17,777	20,045	11,711	6,476
Maricopa	75.46	1,560	26,023.48	537,953	539,513	17,960	9,932
Mohave	.....	.....	91,487.48	1,891,214	1,891,214	170,845	94,477
Pima	359.09	7,423	116.29	2,404	9,827	46,782	25,871
Pinal	24.33	503	2,848.71	58,888	59,391	178,402	98,657
Santa Cruz	14.85	307	302.92	6,262	6,569	128,270	70,934
Yavapai	589.69	12,190	26,358.28	544,874	557,064	786,917	435,165
Yuma	266.89	5,517	1,489.90	30,799	36,316	9,899	5,474
Total	1,458.02	30,140	200,708.60	4,149,015	4,179,155	4,377,994	2,421,031

Mine production of gold, silver, copper, lead, and zinc, etc.—Continued.

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Cochise	155,420,887	$20,670,978	9,331,116	$363,914	122,304	$6,238	$23,578,741
Coconino	19,672	2,616	.....	.....	.....	.....	2,701
Gila	73,488,162	9,773,926	21,575	841	.....	.....	9,970,219
Graham	11,838	1,574	.....	.....	.....	.....	1,687
Greenlee	65,558,501	8,719,281	.....	.....	.....	.....	8,745,802
Maricopa	39,583	5,264	371,468	14,487	.....	.....	569,196
Mohave	760,678	101,170	3,718,057	145,004	9,553,050	487,205	2,719,070
Pima	912,652	121,383	769,145	29,997	.....	.....	187,078
Pinal	60,290,636	8,018,654	33,234	1,296	.....	.....	8,177,998
Santa Cruz	2,337,480	310,885	403,272	15,728	116,983	5,966	410,082
Yavapai	34,057,952	4,529,708	169,959	6,628	.....	.....	5,528,565
Yuma	119,359	15,875	185,242	7,225	.....	.....	64,890
Total	393,017,400	52,271,314	15,003,068	585,120	9,792,337	499,409	59,956,029

Ore sold or treated, number of deep mines producing, and average values of ore per ton in Arizona in 1913 and 1914, by counties.

County.	Ore sold or treated.		Number of deep mines, producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1914	Increase (+) or decrease (−).	1913	1914	1913	1914	1913	1914
	Short tons.	*Short tons.*						
Cochise	1,595,385	+35,511	51	45	$17.97	$14.78	$1.34	$1.59
Coconino	63	− 153	3	1	20.06	42.87	.66	1.35
Gila	1,513,800	+12,180	28	25	7.58	6.59	.17	.13
Graham	56	+ 56	.....	3	.....	30.12	.....	2.02
Greenlee	1,684,481	−50,501	17	13	6.23	5.19	.02	.01
Maricopa	39,440	+ 5,176	21	12	18.76	14.39	17.91	13.89
Mohave	204,004	− 2,235	44	43	13.42	13.33	9.81	9.73
Pima	9,657	−12,709	45	28	19.11	18.60	1.91	2.92
Pinal	2,462,459	+83,636	18	27	3.72	3.32	.07	.06
Santa Cruz	12,823	− 9,839	40	34	31.26	31.96	2.76	6.02
Yavapai	459,982	+12,323	92	81	15.74	11.99	2.28	2.13
Yuma	27,777	+ 4,620	43	26	8.25	2.14	2.51	1.30
Total	8,009,927	+78,065	402	338	8.93	7.49	.80	.82

[a] Value per ton, placer product excluded.

REVIEW OF MINING INDUSTRY BY COUNTIES.

COCHISE COUNTY.

Number of producers, ore sold or treated in Cochise County, Ariz., in 1904–1914, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	14	686,767	$389,437	1,152,466	90,850,611	799,912	.....	$12,440,572
1905	19	950,765	430,388	1,453,312	108,498,440	2,677,980	.....	18,359,810
1906	21	1,195,648	[a] 618,270	[a] 1,757,369	130,029,016	2,124,605	.....	27,012,409
1907	49	1,080,986	[a] 435,560	[a] 1,411,301	110,024,926	1,654,773	.....	23,459,707
1908	27	1,136,662	[a] 529,318	[a] 1,630,749	126,554,764	1,978,097	173,313	18,190,070
1909	38	1,222,095	496,951	1,454,390	140,810,472	2,004,018	713,116	19,683,276
1910	38	1,294,282	[a] 587,476	[a] 1,208,274	145,310,623	1,176,416	.....	19,746,155
1911	44	1,167,237	783,981	1,946,319	132,290,007	6,907,388	22,423	18,663,891
1912	50	1,381,158	910,315	1,962,644	147,654,661	3,776,867	23,800	26,651,961
1913	51	1,559,874	808,095	2,127,191	165,103,854	7,844,204	57,566	28,032,384
1914	46	1,595,385	[a] 1,014,675	[a] 2,753,953	155,420,887	9,331,116	122,304	23,578,741
Increase (+) or decrease (−) in 1914	.....	+35,511	+206,580	+626,762	−9,682,967	+1,486,912	+64,738	−4,453,643

[a] Includes small placer production.

Forty-six producers reported the output of 1,595,385 tons of ore in 1914, an increase of 35,511 tons over the production of 1913, when there were 51 producers. The total value of the metals from this ore was $23,578,513, against $28,032,384 in 1913, a decrease of $4,453,643. The total average value per ton decreased from $17.97 in 1913 to $14.78 in 1914, and the gold and silver value in this ore increased from $1.34 to $1.59 a ton. The output of gold, silver, lead, and zinc increased—gold valued at $808,095 in 1913 increased to $1,014,675 in 1914; silver, from $1,284,823 in 1913 to $1,522,936 in 1914; lead, from $345,145 in 1913 to $363,914 in 1914; and zinc, from $3,224 in 1913 to $6,238 in 1914. The value of the copper decreased from $25,591,097 in 1913 to $20,670,978 in 1914. The larger part of the copper ores produced in the county are smelted directly. Of this kind of ore 1,387,997 tons were treated, containing 38,332.36 ounces of gold, 1,634,077 ounces of silver, and 153,735,000 pounds of copper. One shipment of copper ore containing a little lead was sent directly to a lead plant. There were also 24,214 tons of lead ores shipped to lead plants outside the State, containing 1,906.35 ounces of gold, 339,593 ounces of silver, 403,940 pounds of copper, and 9,051,817 pounds of lead. Of the copper ores smelted, it is estimated that 737,582 tons were oxidized and 650,415 tons were sulphides. Of the lead ores, 252 tons were oxidized and 23,962 tons were sulphides. One producer reported some placer gold.

California district.—An output of 105 tons of copper sulphide ore containing a little silver was shipped directly to the smelters from the Willie Rose claim. The property is opened by a vertical shaft about 138 feet deep.

Cochise or Johnson district.—Eleven producers shipped to smelters 20,507 tons of ore containing $254 in gold, 32,449 ounces of silver, 2,145,376 pounds of copper, and 103,717 pounds of lead, valued in all at $307,578, or an average value per ton of $15. The larger part of the shipments consisted of copper sulphide ore produced from the Republic and Mammoth mines. This property is opened by incline shafts and was operated only the first part of the year. Large shipments of oxidized copper ore were also made from the Copper Chief claim, opened by an incline shaft 400 feet deep, which is reported to have a pitch of 38 degrees. The operators of this property were still working in the oxidized zone at a vertical depth of 250 feet. Shipments of copper ore were also made from the Black Prince, Peabody, and Climax properties. Some oxidized lead ore was shipped from the Buena Vista and Horse Fall prospects and also from the Texas-Arizona property.

Dos Cabezas district.—The reported output of 3 deep-mine producers and a small quantity of placer bullion was valued at $10,320. The larger part of the ore mined was treated at a mill producing gold and silver bullion. There were also 106 tons of copper sulphide ore and 17 tons of dry or siliceous ore shipped. The largest part of the district production was from the Dives mine, the ore from which was treated in an old stamp mill at Dos Cabezas. Development work still continues on the Bachelder group, owned by the Mascot Copper Co., which made a small test shipment of copper sulphide ore to the smelter. This property is opened by a vertical shaft 400 feet deep and an adit 2,000 feet long. There are also shafts

sunk on the tunnel level 200 to 400 feet deep. The construction of the Mascot & Western Railroad was commenced late in January, 1915, to connect the Mascot Copper property with Willcox, a station on the Southern Pacific Railroad. This line was completed June 15, 1915.

Hartford or Huachuca district.—There were 214 tons of ore mined in the district in 1914, of which 146 tons, containing gold, silver, copper, lead, and zinc, were shipped directly to the smelters. A small quantity of concentrates was also shipped containing lead and zinc, with small quantities of gold, silver, and copper. In all, the district production was valued at $9,526, or an average value per ton of $44.51. The principal property producing was the Nellie James, which had the largest output of shipping ore containing lead and zinc. A small quantity of ore was also produced from the Copper Glance and the Smuggler claims.

Tombstone district.—Six producers shipped 6,063 tons of ore, containing $28,532 in gold, 108,868 ounces of silver, 14,217 pounds of copper, 234,345 pounds of lead, and 39,324 pounds of zinc, valued in all at $101,772, or an average value per ton of $16.79. The greater part of the district production came from the holdings of the Tombstone Consolidated Mines Co., now operated by the Bunker Hill Mining Co. of the Phelps-Dodge interests, to which the property was transferred on June 23, 1914, operations beginning July 6. The property will be operated in the future under the name Bunker Hill Mines Co.[1]

A thorough and systematic sampling of the old workings is being carried out, and the ore extracted will be treated in a test mill to determine whether profit can accrue from their treatment. If the results are encouraging, there is probably a large quantity of ore above water level which could not have been handled profitably when the mines were first opened, but which may return a small profit with improved methods of treatment.

* * * There were produced and sold * * * from the recently acquired properties at Tombstone 1,937 tons of ore, yielding 1,586 pounds of copper, 46,899 pounds of lead, 32,188 ounces of silver, and 437 ounces of gold.

Production was also reported from the Old Guard and the Solstice claims.

Turquoise or Courtland district.—In 1914 the mines of the district produced 166,290 tons of ore and tailings, which yielded $154,972 in gold, 668,688 ounces of silver, 1,586,237 pounds of copper, and 15,015 pounds of lead, valued in all at $736,313. Of this production, 103,924 tons were treated by the cyanidation process and yielded gold and silver bullion, and 44,218 tons, chiefly sulphide, were shipped directly to the smelter. The largest producer was the Commonwealth property, which has a 30-stamp mill equipped for cyanidation. According to the printed annual report of the company:[2]

A total of 70,650 tons of ore was mined and milled, at a profit of $40,386.09. The gross value of the ore was a little lower than for the preceding period, but the loss in tailing was also less, and the amount realized per ton was practically the same.

The decrease in the grade of ore sent to the mill was due to the lower price received for the silver contents. The average price received during the period was 51.82 cents per ounce, as compared with an average price of 58.01 cents during the previous six months.

[1] Phelps, Dodge & Co. Ann Rept. for year ending Dec. 31, 1914.
[2] Commonwealth Mining & Milling Co. Rept. for eight months ending Dec. 31, 1914.

All the properties in the vicinity of Courtland and Gleeson were closed at the end of 1914, except that some lessees remained at work taking out high-grade copper ore from the Great Western property and the Germania mine. Both of these properties are said to be exhausted, except for small high-grade copper bodies. The Leonard mine, at Gleeson, closed when the Shannon smelter ceased treating ore because of the European war.

According to the Calumet & Arizona Mining Co.,[1] its Courtland property was turned over to lessees late in 1913, and work was continued until August 1, 1914. In all, 472 tons of high-grade oxide ore were shipped to the smelter from the Germania property.

Warren or Bisbee district.—Eleven producers reported an output of 1,401,833 tons of ore, containing $824,457 in gold, 1,937,993 ounces of silver, 151,612,811 pounds of copper, and 8,937,056 pounds of lead, valued in all at $22,409,216, or an average value per ton of $15.99. Of the total output of ore 1,383,787 tons were smelted, consisting largely of copper ore which was treated at Douglas, Ariz., and lead ore which was treated at a smelter outside of the State. At the Copper Queen mine 3,393 tons of ore were treated by leaching and 11,502 tons of old slag were resmelted. At the concentration mill on the Copper Queen property 713 tons of copper concentrates were produced. During 1914 there were shipped from the Copper Queen property,[2] principally to Douglas, 705,749 tons of ore, old dump slag, precipitates, and other material; to El Paso, 23,930 tons of lead ore; and to the Bisbee concentrator, 3,150 tons of low-grade copper ore. The metals contained in this material amounted to 15,769 ounces of gold, 1,036,672 ounces of silver, 86,066,143 pounds of copper, and 8,889,175 pounds of lead. The average metal content of the copper ore was 0.02 ounce of gold, 1.03 ounces of silver, 6.15 per cent of copper; that of the lead ore, 0.08 ounce of gold, 13.92 ounces of silver, 0.83 per cent of copper, and 18.57 per cent of lead.

The following is from the annual report of Phelps, Dodge & Co. for the year ending December 31, 1914:

> Owing to the curtailment of production during the last four months of 1914 the tonnage of ore mined, slag reclaimed, and precipitates made is below that of the previous year by 134,652 tons, and the output from the reduction works was correspondingly reduced by 13,453,565 pounds of copper.
>
> Shipments of lead-silver ore to El Paso, however, were increased by 8,357 tons over the year 1913.
>
> The ore in stock at Douglas was increased 27,359 tons.
>
> Though the production was curtailed * * * the cost of both the mining and smelting of the copper was slightly reduced during the year. * * *
>
> The operation of the reduction works are from year to year modified by the demands of the mine to draw upon more highly sulphuretted ore, or those with a more earthy gangue. * * *
>
> The development of several million tons of concentrating ore in the Sacramento Hill imposes on the company the necessity of erecting a concentrator. In order to solve subordinate problems a small test mill, with a capacity of 90 tons a day, was constructed. The best results were obtained by combined hydraulic and flotation methods, flotation increasing the mechanical recovery by about 12 per cent, and raising the total saving to 87 per cent. * * *
>
> Fifty million pounds of copper were taken out in the first six months, but in August shipments were materially reduced. The workings include so large an area that when curtailment of production is resorted to it is found to be more economical to completely close one or more shafts and their adjacent territory than to shrink the output of the whole mine.

[1] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[2] Phelps, Dodge & Co. Ann. Rept. for year ending Dec. 31, 1914.

The Copper Queen Co. recently placed in operation its new flume-type scrap-iron precipitating plant at Lowell. Construction began early in October, 1913, under a 60-day contract, with all material furnished to the contractor. Mine water was turned into the plant in February, 1914.

The plant[1] is designed to handle from 300 to 2,500 gallons of mine water per minute, varying according to the seasons, the maximum amount usually being pumped during July and August. * * *

The water, upon entering the plant proper, has practically the temperature of the air. This is due to its 3,040 feet of travel in an open flume before reaching the plant.

The plant is so designed that about 300,000 gallons of the outflow may be pumped back daily to the Holbrook shaft through an 8-inch wood-lined pipe by means of a triplex geared pump. The upper levels of the Holbrook mine were worked out years ago and the stopes gobbed with moderately rich waste. This offers an attractive field for enriching the mine water; so these old workings were drifted and crosscut and a system of pipes introduced which distributed the barren water through those drifts. This water percolates through the old gob or stope filling, leaching out the copper, and is collected in the sump on a lower level to be pumped back to the precipitating plant again. Water is also pumped through burning sulphide stopes to collect copper there.

The average extraction for the period July 1, 1914, to September 1, 1914, was 98.11 per cent. A series of samples taken from a representative flow of water as it passed different points in the plant gave the following data:

Precipitating plant extraction.

Content.	Grams per liter.			
	Copper.	Ferric iron.	Free acid.	Extraction.
				Per cent.
Water leaving the mine, heads	0.424	0.116	0.360	0.00
Entering precipitating tanks	.281	.051	.140	33.72
Leaving precipitating tanks	.169	.031	.....	60.14
Leaving the plant, tails	.010	.010	.140	97.66

From the analytical data it may be seen that 33.72 per cent of the copper is extracted in the flume leading to the plant, 26.41 per cent of the total copper content is extracted in the six precipitating tanks, and 37.52 per cent in the flumes, leaving 2.34 per cent in the tails. Extraction also tends to vary with the seasons, being slightly higher in the winter and lower in the summer or rainy season.

The cement copper from the new plant is expected to be similar in quantity to that produced by the old plant. A typical sample of this precipitate contained 35 per cent moisture and the dried sample assayed: 39.12 per cent Cu; 16.5 per cent Fe; 5.2 per cent SiO_2; 2 per cent CaO; 12.9 per cent Al_2O_3; and 1.4 per cent S. Calculating from the copper, ferric iron, and free acid in heads and tails assays, it may be seen that theoretically 1.23 pounds of iron are consumed per pound of copper produced. Assuming the scrap to be 85 per cent, Fe gives 1.45 pounds iron per pound of copper produced.

Development at the Superior & Pittsburg property[2] in 1914 was 66,465 feet, compared with 47,201 feet in 1913. The copper ore from the mines, mostly sulphide, sampled at the Calumet & Arizona smelter, amounted to 485,796 dry tons, and in addition 20,305 wet tons of low-grade sulphides were shipped to the El Paso smelter, for which a premium was received for the high sulphur and iron content.

[1] Coats, C. M., and Allen, G. L., Precipitating plant of the Copper Queen mines; Eng. & Min. Jour., Jan. 2, 1915, p. 17.

[2] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

Cole shaft.[1]—The large body of oxide ore on the 900-foot level of the Granville claim has been blocked out and extensively mined during the year. * * * On the 1,000-foot level 50 feet of sulphide was cut, and recently considerable oxide ore was found. This ore is a continuation of the Granville ore body. * * * Old sulphide stopes on the 1,000 and 1,100 foot levels of the Cole were opened up on this claim and steady shipments made during the year.

Junction shaft.—During 1914 some exploration work was done on the Ormond claim on the 1,400 and 1,500 foot levels and ore bodies of low-grade ore were found. * * * Farther south on the Baton Rouge claim we have developed on the 1,300, 1,400, and 1,500 foot levels what is doubtless a very large body of low-grade ore. The ore is proved on these three levels and has an extent of 300 feet by 150 feet at some points. The ore will probably average about 2 per cent copper. * * *

The development as a whole of the Junction has shown great tonnages of 2 per cent to 4 per cent ore.

Briggs shaft.—On the 1,200 and 1,300 foot levels on the Hard Cash and "16 to 1" claims a body of oxide ore has been opened up. This ore occurs in width from 3 to 15 or 20 feet at different points and on both levels is developed for over 200 feet. * * *

The Hoatson shaft was closed down in August, and since that time no work has been done except the blocking up and putting in shape of the shaft timbers.

There was shipped from the Shattuck-Arizona mine[1] 84,317 dry tons of copper ore to Douglas, Ariz., and 52 tons of lead ore to El Paso, Tex., in 1914, which produced 10,846,918 pounds of copper, 198,419 ounces of silver, 2,444.91 ounces of gold, and 14,065 pounds of lead.

The annual report of the Shattuck-Arizona Co. says:

The mine output during the first seven months of the year showed a good increase over the corresponding period of 1913, and production was being maintained at the rate of about 15,000,000 pounds of copper per year. The production of gold and silver was also higher for the same period.

Owing to European war conditions output was reduced 50 per cent during the months of August, September, and October. Ore shipments were discontinued October 23, 1914, to await more favorable conditions in the copper market.

During the year we have opened up very favorable copper ore bearing territory on the 200, 400, and between the 700 and 850 foot levels. These new ore bodies indicate an addition in ore reserves which will more than offset the output of copper ores during the year.

We continue to expose important tonnages of siliceous gold and silver bearing ores between our 300-foot level and the 100-foot level. Development of the lead-ore territory was discontinued and only one lead-ore shipment was made owing to the very low price offered for lead during the year.

At the mines of the Calumet & Arizona Mining Co.[2] production was reduced early in August. The annual report of the company says:

During the first seven months of 1914 we operated on a record basis of 65,000,000 pounds production per year for the Bisbee mines, and notable reductions were made in all of our unit (ton) costs.

Early in August * * * a curtailment of 50 per cent was put into effect, both at the mines and the smelter.

The Oliver and Hoatson shafts were closed down and every effort was made to hold costs as low as possible under this reduced production. All requisitions for supplies were cut to the minimum, and in some cases, as with coke, no new purchases were made until early in December.

In spite of the fact that development work was held at normal and the mines were operated for five months of the year under a 50 per cent production, the mining cost for the year showed a reduction of 53 cents per ton and the smelter operating cost a reduction of 35 cents per ton over 1913.

The cost of copper showed an increase of fifty-four one-hundredths of a cent per pound, due to curtailment and the fact that the grade of ore mined was dropped deliberately in order to add to the longevity of the mines.

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[1] Shattuck-Arizona Copper Co. Ann. Rept. for year ending Dec. 31, 1914.
[2] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

One of the most gratifying results of the year's work was the increase in ore reserves. A net gain of 556,427 tons was made, equivalent to a 52.8 per cent increase over the reserves of December 31, 1913. This gain was, of course, in addition to the ore mined and shipped, which amounted to 608,126 tons. However, owing to a decrease in grade of ore in total ore reserves, the amount in pounds of copper contained shows only a 31.7 per cent increase as against a 52.8 per cent increase in tonnage.

Large shipments of copper sulphide ore were made from the Wolverine and Arizona property and from the Twilight group, which was operated up to the month of August, when the smelters discontinued the purchase of copper ores. From the Juniper Flats property one carload of copper ore and lead ore, both oxidized, was shipped. The property is opened by a shaft 25 feet deep and by open cuts on the surface.

COCONINO COUNTY.

An output of 63 tons of ore, containing copper and a small quantity of gold and silver, came from the Francis district, the only district producing copper ore in Coconino County in 1914.

GILA COUNTY.

Number of producers, ore sold or treated in Gila County, Ariz., in 1905–1914, and content in gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	10	241,328	$50,997	84,982	24,991,794	.....	$4,001,046
1906	14	415,471	47,916	122,098	28,492,391	.....	5,628,753
1907	42	444,860	[a] 62,039	[a] 94,062	36,875,993	161,523	7,507,880
1908	24	442,430	54,780	164,900	37,380,914	70,487	5,079,418
1909	23	445,688	[a] 25,408	[a] 155,493	39,451,896	13,442	5,235,588
1910	46	312,057	[a] 25,229	[a] 174,696	31,330,222	6,102	4,098,772
1911	44	735,432	[a] 50,310	[a] 247,813	49,226,341	10,466	6,335,415
1912	32	1,450,201	33,939	264,941	63,969,423	47,349	10,753,964
1913	28	1,501,620	46,216	348,198	71,609,847	515,849	11,378,751
1914	27	1,513,800	[a] 44,535	[a] 272,907	73,488,162	21,575	9,970,219
Increase (+) or decrease (−) in 1914	.....	+12,180	−1,681	−75,291	+1,878,315	−494,274	−1,408,532

[a] Includes small placer production.

Twenty-five producers in Gila County reported an output in 1914 of 1,513,800 tons of ore, an increase of 12,180 tons over that produced by 28 properties in 1913. The total average value per ton of the ore decreased from $7.58 to $6.59 in 1914, and the gold and silver value per ton from 17 cents to 13 cents. All the metals decreased in value. Gold was valued at $44,535, a decrease of $1,681 compared with 1913; silver decreased in value from $210,312 to $150,917; copper, from $11,099,525 to $9,773,926; lead, from $22,697 to $841; and the total value decreased from $11,378,751 to $9,970,219. Of the copper ores produced, 1,334,907 tons were of concentrating grade and produced 93,531 tons of concentrate containing 1,469 ounces of gold, 141,462 ounces of silver, and 47,748,598 pounds of copper. There was an increase both in the quantity of concentrate and in the gold and copper contained. The crude ores, mostly copper ore, shipped directly to smelters amounted to 178,068 tons, against 276,480 tons pro-

duced in 1913. The crude ores in 1914 contained 671.37 ounces of gold, 131,441 ounces of silver, 25,701,238 pounds of copper, and 21,575 pounds of lead. There were also 817 tons of old slag, containing copper, resmelted. The ore containing lead was shipped to a smelter outside of the State. Of the copper ores smelted 135,828 tons were oxidized and 42,169 tons were estimated as sulphides. The smelting ores produced were valued at $3,505,672, an average value per ton of $19.69, and the concentrates, chiefly copper, were valued at $6,459,160, an average value per ton of $69.06.

Banner district.—Four deep mines produced 3,191 tons of ore, which, with the output of one placer included, yielded $693 in gold, 3,552 ounces of silver, and 592,271 pounds of copper, valued in all at $81,429. The larger part of the ore, or 3,183 tons, was shipped directly to the smelter, and a mill test was made on the remaining ore producing gold and silver bullion. The average value of the ore shipped amounted to $25.49 a ton. Large outputs of ore were made from the Snyder and the O'Carroll properties, both of which produced copper oxidized ore.

Globe district.—Nineteen deep mines produced 1,510,593 tons of ore, the larger part of which, or 1,334,907 tons, was concentrated to 93,531 tons of concentrates, containing 1,469 ounces of gold, 141,462 ounces of silver, and 47,748,598 pounds of copper. The ore smelted directly amounted to 174,869 tons and contained 642.36 ounces of gold, 127,621 ounces of silver, 25,108,428 pounds of copper, and 21,575 pounds of lead. The lead was in a small shipment which went to a smelter outside of the State. There were also 817 tons of old slag resmelted, containing 38,326 pounds of copper.

The Old Dominion mine[1] produced 129,813 dry tons of ore in 1914, yielding 17,816,284 pounds of fine copper, 33,311 ounces of silver, and 602.98 ounces of gold. There were milled 30,159 dry tons of ore, which assayed 4.69 per cent of copper, as compared with 47,785 tons, assaying 3.56 per cent of copper in 1913. The smelting ore amounted to 99,507 tons of 8.28 per cent grade in 1914, as compared with 120,257 tons of 6.85 per cent grade in 1913.

The company's report says:

> During the year the west end of the mine has furnished the major portion of the ore production. The tonnage from this part of the mine has consisted almost entirely of high-grade oxide ore, which was sent direct to the smelter.
>
> The stopes above the tenth and eleventh levels have continued to provide small tonnages of a good grade of ore, but necessitating considerable sorting and handling, as is invariably the case when cleaning up the remnants of an ore body. * * *
>
> The ore body on the fourteenth level has been extended west, and the necessary drifts and raises have been advanced to keep the ground opened up ahead of ore extraction. On the fifteenth level a new footwall drift, has been driven around the heavy stoping ground in blocks 1 and 2 west. The level has also been extended 200 feet west into block 6 west and a crosscut run to the footwall. * * *
>
> Between the sixteenth and fifteenth levels the ore, as at present developed, has been somewhat more irregular than above the fifteenth, but what stopes have been opened up have shown an excellent grade of ore. On the sixteenth level the main foot wall drift has been advanced into block 13 west and a crosscut driven into the vein in block 11 west, which showed promising leached ground. In block 7 west a 3-compartment winze was sunk during the year to the eighteenth level and crosscuts started to the footwall with a view to proving up the extension of the west ore body on those levels in advance of the time

[1] Old Dominion Copper Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1914.

that the extraction drift on the eighteenth level from the "A" shaft could reach that point. * * *

The center part of the mine has continued to furnish the larger portion of the concentrating ore—mostly from the ninth and tenth levels. * * *

Active prospecting and development work at the eastern end of the mine has opened up the vein in a most encouraging manner. * * *

The old stopes and fills above the eighth level have been worked during the year, producing iron ore, with good copper values, suitable for fluxing material. The ore derived from leases during the year has been inconsequential. * * *

During the year 1,349.21 million gallons were pumped from the mine, compared with 1,284.71 million gallons in 1913. The average flow of water in the mine during 1914 was 3,754,542 gallons per 24 hours. The minimum rate of the flow was 3,350,000 gallons per 24 hours in January, and the maximum flow was 5,625,000 gallons per 24 hours on December 31. * * *

The old mill was run for almost 10 months in the year, and toward the end was doing poor metallurgical work, owing to the dilapidated condition of the old equipment. At the end of October the new concentrator was put into commission and since that time has been running practically continuously and giving good satisfaction. Several minor corrections and changes have been made in the original flow sheet and will probably continue to be made in the future in an endeavor to still better the final recovery. A sixteen-box 300-ton Mineral Separation Co. oil flotation machine has been installed on the lower table floor and is at present treating slime tailings from the vanners in the old unit, which are being used temporarily. * * * Its operation to date has considerably increased the copper saving. * * *

A comparison of smelting costs for 1914 with the previous year shows as follows, based on tons new charge smelted:

	1914.	1913.
	$2.669	$2.629
Tons charge smelted	207,595	300,926

Notwithstanding the greatly decreased tonnage smelted in 1914, the costs are only slightly higher than in the preceding year. * * * Only a very small quantity of foreign sulphide has been purchased during the year, the United Globe mines and the concentrates having furnished the necessary sulphide to matte the copper. All the flue dust produced was handled in our own plant during the year. * * *

The cost of converting per ton of fine copper produced in bullion in 1914 compares with the previous year as follows:

	1914.	1913.
	$5.65	$9.19
Pounds blister copper produced	30,448,901	30,811,441
Pounds fine copper produced	30,210,361	30,572,863

The 12-foot converter shell that was put in service in July, 1913, was in continuous operation throughout the year, and with the exception of two days' production handled all the material produced. This shell has now produced over 23,350 tons of copper. No money has been expended for converter relining during the year on account of the long life of the present shell.

There were produced from the United Globe mine[1] 155,205 tons of ore in 1914, compared with 162,835 tons of ore and 5,084 tons of old slag in 1913. The oxidized copper ore amounted to 14,352 tons, averaging 6.38 per cent of copper; sulphide copper ore, 12,640 tons, averaging 1.69 per cent; concentrating ore, 121,812 tons, averaging 3.23 per cent; and silica converter lining, 6,402 tons, averaging 7.44 per cent. Shipments were made to the Old Dominion and the El Paso smelting plants.

The company's annual report says:

The principal tonnage of ores has consisted of concentrating ore from the twelfth to the sixteenth levels, though stopes have been worked above the twelfth in blocks 35, 36, and 37. The fifteenth and sixteenth levels on the Gladiator vein have been opened between blocks 29 and 34, and have contributed ore

[1] United Globe Mines Ann. Rept. for year ending Dec. 31, 1914.

of a somewhat higher grade. Through the Grey shaft concentrating ores with high sulphur contents have been extracted. This vein will be developed between the seventh and twelfth levels during the coming year and should be productive of good tonnages of concentrating ore.

The principal product of the United Globe mines being concentrating ore, and the Old Dominion concentrator and its auxiliary flotation plant having been under construction during the greater part of the year, the output of the mines has been partially restricted.

The Miami mine[1] produced 1,096,633 tons of ore concentrated to 44,579 tons of copper concentrates, from which was recovered 33,296,010 pounds of refined copper. The ore concentrated averaged 2.28 per cent of copper and the concentrate 39.31 per cent of copper.

The company's annual report says:

During the year 1914 the net production of refined copper was 33,296,010 pounds derived from the treatment of 1,096,633 tons of ore. For the last five months of the year the property was operated on a reduced scale of production due to the unsettled condition of the copper market occasioned by the European war. * * *

Section 6 of the mill was operated successfully during the year with the improvements and changes mentioned in last year's report, and the remodeling of the whole mill to correspond with this section is well under way, and will increase the capacity of the mill to 4,200 tons a day with an increased ratio of saving.

Mining in both the shrinkage and slicing areas of the mine was carried on with increased efficiency, and at the same time the Captain ore body was prepared for mining. * * *

The ore reserves are as follows: High-grade sulphide ore, 19,500,000 tons, at 2.40 per cent of copper; low-grade sulphide ore, 17,000,000 tons, at 1.21 per cent copper, making a total of 36,500,000 tons, at 1.85 per cent copper. Not included in the above is 6,000,000 tons partially developed mixed sulphide and oxide ore carrying about 2 per cent of copper. Experiments in the treatment of this ore are still under way, and it is hoped that within a reasonable time this tonnage will be available for treatment. * * *

The milling plant was operated at full capacity during the first seven months of the year, but for the last five months on a greatly reduced scale. On account of the increased tonnage handled during the first period, the efficiency of the concentrating process suffered somewhat and results were not quite up to the standard of the previous year. As before stated, plans were completed, based on experiments made in previous years, for increasing the efficiency of the process and enabling the handling of larger tonnages. The change consists principally in finer grinding and additional table treatment on the sand floor of the mill and improved methods of handling and treating the slime products. The increased table capacity required on the sand floor will be obtained by using a certain number of double-deck tables and the finer grinding will be accomplished by the installation of 8-foot by 66-inch Hardinge conical pebble mills in the sand-floor tunnels, the product of which will be raised by elevators and reclassified for table treatment. The material leaving the sand floor will have the fine sands removed in 8-foot conical tanks, the overflow of which will pass to 6 Dorr thickeners 46 feet in diameter by 10 feet deep, 1 to each section, and located outside of the present mill building. The thickened pulp from these machines will join the reject from the slime floor tables for further treatment. This change in treatment when in full operation will result in a metallurgical efficiency as high as is possible with the present state of the art.

With the increased tonnage capacity of the plant, the original mill bins do not furnish sufficient storage and this is being increased by inclosing the open spaces between the original circular bins. The storage capacity for crushed ore will be raised to about 10,000 tons.

Experimental work done during the year, looking to the recovery of copper values present in the ore in oxidized form and the treatment of oxidized ores, has given encouraging results, but for the present, actual work is being confined to improvements in the sulphide-ore treatment. * * *

[1] Miami Copper Co. Ann. Rept. for year ending Dec. 31, 1914.

The results of milling operations for the year are given below:

Operation of Miami copper mine, Arizona, in 1914.

	Quantity.	Average of copper.	Cost of refined copper in concentrate f. o. b. cars at Miami, Ariz., in 1914.	
			Per ton of ore.	*Per pound of copper.*
Ore milled.....short tons..	1,096,633	*Per cent.* 2.28	.....	.....
Concentrate produced.....do....	44,579	39.31	.....	.....
Copper in concentrate.....pounds..	35,048,445	.....	.....	.....
Copper recovered per ton of ore.....do....	31.96	.....	.....	.....
Mill extraction.....per cent..	69.93	.....	.....	.....
Mining.....	.....	.....	$1.1876	$0.039205
Milling.....	.....	.....	.4996	.016456
General.....	.....	.....	.2717	.008951
Total.....	.....	.....	1.9589	.064612

Another mine will soon be a large producer of copper from low-grade disseminated copper ores.

Copper production will begin at Inspiration[1] during the month of June, 1915. When construction began it was estimated that production might start at the beginning of the current year. The explanation of the discrepancy in the above dates is accounted for by the change of mill-construction plans involved in the adaptation of the flotation process for treating the company's ore.

In the beginning a water concentrator of the regulation type was designed and structural steel for the mill building contracted for. Flotation experiments in the treatment of the ores subsequent to this contract resulted so favorably that this steel order was suspended and finally canceled. New details of treatment applicable to the new process were worked out, based on current experimental work, and a new start in mill design was made. As a consequence it was not until early in the current year that much of the machinery in the grinding and flotation departments was ordered. The resultant combination flow sheet, involving the practice of both flotation and wet concentration, will show a material increase in the copper recovery from ores treated over either process when used alone.

At the time the original experimental unit was started, January, 1913, no copper ore was being treated on a commercial scale by flotation in this country. The results from the 50-ton per day flotation test unit first installed led to the adoption of the process and the building of a larger test plant, with units of the size thought suitable for the final mill installation. This test plant ran through the whole of the past year. Experiments were conducted to determine the best grinding machines, as well as the necessary fineness of the grinding for best results. Parallel tests were run on various flow sheets and on five different flotation machines. Systematic investigation, both in actual practice and in the laboratory, were made of various flotation oils. The scheme of treatment worked out may be stated, in general terms, as follows:

At the mine: Crushing ore to 4-inch maximum size in gyratory crushers.

At the mine: Crushing this ore to 1½-inch maximum size by Symons disk crushers.

At the mill: Crushing this product in Marcy ball mills to pass 48-mesh screen.

At the mill: Treatment of this product in flotation machines.

At the mill: Separation of flotation tailings into sand and slime.

At the mill: Treatment of sand on concentrating tables.

At the mill: Retreatment of slime in flotation machines.

At the mill: Dewatering concentrates in filter plant. * * *

In the continuous running from August 1, the saving of copper occurring in the ore in sulphide form has averaged 86.7 per cent, and during the past month has averaged 90.3 per cent. * * *

[1] Inspiration Consolidated Copper Co. Ann. Rept. for year ending Dec. 31, 1914.

During 1914 the test mill treated 172,722 tons of ore averaging 1.52 per cent copper, produced from the development work of the mine; 28 per cent of this came from without the ore body—that is, from low-grade ore pierced by the drifts and raises driven from below the regular ore body. The Inspiration concentrates will probably run from 28 per cent to 32 per cent copper and contain sufficient sulphur to make a suitable grade of matte in smelting. * * *

The mill will consist of 18 sections, each one of which, it is expected, will have a capacity of 800 tons per day. The first nine of these sections we expect to complete almost simultaneously, giving substantially the milling capacity contemplated in the original plans. The other sections will be completed in rotation and will be ready to operate before the end of this year. * * * During the year 19⅛ miles of development work was done, making the total to date 42.9 miles.

According to the annual report of the Arizona Commercial Mining Co.[1] for 1914 there was shipped during the year 3,291 dry tons of ore, averaging 5.37 per cent of copper. Of this quantity, 200 tons came from the tenth and twelfth levels and 3,091 tons from the thirteenth level. Shaft sinking consisted of the completion of the Copper Hill shaft to 9 feet below the fourteenth level.

Other properties yielding important shipments of ore were the Copper Hill, Iron Cap and Bird, Summit, Rose and Newman, Black Warrior, and Mercy.

Mazatzal district.—The Copper Butte group produced oxidized copper ore in 1914 containing silver with a trace of gold. The property is opened by an adit 350 feet long.

GRAHAM COUNTY.

A small quantity of oxidized copper ore containing some silver was shipped from the vicinity of Mount Turnbull by lessees of the Jackson group, which is opened by open cuts on the surface of the deposit. Some copper oxidized ore was also shipped from the Copper Bell prospect in the Stanley Butte district.

GREENLEE COUNTY.

Number of producers, ore sold or treated in Greenlee County, Ariz., in 1905–1914, and content in gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	a 9	952,509	$46,222	57,191	53,939,212	800,000	$8,532,882
1906	a 18	1,259,161	55,809	130,904	59,270,459	221,600	11,595,345
1907	a 35	1,418,499	b 30,513	b 87,578	62,720,962	14,142	12,633,256
1908	a 30	1,508,287	b 28,703	b 124,531	77,149,079	30,255	10,279,652
1909	a 25	1,566,989	b 38,682	b88,082	71,826,650	44,729	9,423,875
1910	23	1,561,167	b 48,191	b 147,000	72,878,094	31,576	9,384,511
1911	23	1,551,220	31,541	104,429	70,926,330	30,734	8,954,062
1912	27	1,746,905	36,220	77,743	76,848,299	.....	12,764,001
1913	18	1,734,982	b 17,353	b 36,059	69,466,560	.....	10,806,450
1914	16	1,684,481	b 20,045	b 11,711	65,558,501	.....	8,745 802
Increase (+) or decrease (−) in 1914	.....	−50,501	+2,692	−24,348	−3,908,059	.....	−2,060,648

a Includes small district production from Graham County.
b Includes small placer production.

The output in Greenlee County in 1914 by 13 producers from deep mines amounted to 1,684,481 tons of ore, 50,501 tons less than was reported by 17 producers in 1913. This ore averaged $5.19 a ton in

[1] Arizona Commercial Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

1914, against $6.23 in 1913. Practically no gold or silver is recovered in the refining of the copper bullion, only one property being credited with the total content of its ores reported to be saved in the refining of the bullion. If the total output of ore in the county be considered in arriving at an average value per ton, the gold and silver is shown to amount to only a few cents a ton. Of the ore produced in the county 1,513,865 tons were of concentrating grade and produced 178,988 tons of concentrates, which contained $3,142 in gold, 200 ounces of silver, and 49,964,102 pounds of copper, valued in all at $6,648,479, or an average value per ton of $37.14. The crude ore smelted directly amounted to 161,713 tons, containing $14,635 in gold, 11,489 ounces of silver, and 15,220,479 pounds of copper, valued in all at $2,045,312, or an average value per ton of $12.65. Most of the copper ore smelted, or 158,438 tons, was oxidized, and 2,786 tons were sulphides. The output of 3 placer producers was $2,268 in gold and 22 ounces of silver.

Copper Mountain and Greenlee districts.—The Detroit Copper Co.[1] produced in 1914 from its mines 472,194 tons of ore of an average grade of 2.899 per cent of copper.

The annual report of Phelps, Dodge & Co. says:

A distribution of this tonnage over the various mines and into the different classes is as follows:

Mine.	Concentrating ore.	Smelting ore.	Quartz.	Talc.	Total.
Ryerson	217,086	790	.....	.....	217,876
Yankie	84,803	316	.....	.....	85,119
Copper Mountain	124,476	4,165	.....	.....	128,641
Arizona Central	31,906	117	7,159	128	39,310
Colorado	1,202	.....	.....	.....	1,202
Antietam	.....	46	.....	.....	46
Total	459,473	5,434	7,159	128	472,194

In addition to the above tonnage from the company's own operations, there were produced 773.3 tons of tribute ore and copper precipitates. A summary of the total and the contribution of each mine follows:

	Tonnage.	Grade.
		Per cent.
Concentrating ore	459,473	2.797
Smelting ore	5,434	9.99
Quartz ore	7,159	4.452
Talc	128	3.842
Lease ore, miscellaneous:		
Montezuma	28.8	5.34
London	23.1	4.71
Thomson	55.98	7.59
Copper Bullion	241.84	15.20
Imperial	38.9	10.28
Daisy	10.9	7.18
De Soto	13.8	12.59
Black Jack	5.8	10.00
Blue Jay	16.5	11.51
Hoodoo	4.9	13.47
Yankie	93.87	15.58
Copper Mountain	101.86	11.14
Lone Star	75.35	21.19
Copper precipitates	61.70	52.13
Total	472,967.3	2.922

[1] Phelps, Dodge & Co. Ann. Rept. for year ending Dec. 31, 1914.

Disregarding the lease ore, copper precipitates, and the tonnage of first-class smelting ore mined, the average grade of the ore has been maintained as to concentrating ore and the total ore mined.

The mines of the Arizona Copper Co.[1] produced 38,942,455 pounds of copper in 1914, as compared with 34,230,000 pounds in 1913, an increase of 4,712,455 pounds.

The annual report of the company says:

The total ores mined from the company's properties during the year amounted to 1,079,950 dry tons, and the yield, as indicated by the smelter returns on ores treated, was 36.17 pounds of copper per ton of ore—a decrease of 2.6 pounds per ton as compared with the previous year.

About 95 per cent of the ores mined were concentrating ores, the remaining 5 per cent being direct smelting ores (including pyrites for the converter plant and siliceous ores for converter flux).

Of the total copper produced, 81.4 per cent came from sulphide ores and 18.6 per cent from oxide ores. * * *

During the year 932,954 dry tons of sulphide concentrating ore were treated, of which 716,465 tons, or 76.8 per cent, were treated at No. 6 concentrator, and 216,489 tons, or 23.2 per cent, were treated at the Clifton concentrator.

The average ratio of concentration was 8.42 tons of ore into 1 ton of concentrates.

The increase in ore treated was due to the enlargement of No. 6 concentrator, which at the beginning of the period was treating 1,500 tons per day, and at the close of the period from 2,400 to 2,500 tons per day (24 hours running time). The concentrator has now a capacity of approximately 3,000 tons per day, but, owing to the restriction of output, the concentrator is not running full time.

The work of enlargement of the concentrator, begun in 1912, was completed immediately prior to the close of the period under review, and all the machinery installed is running smoothly.

The Clifton sulphide concentrator was closed during the month of August.

During the year the oxide concentrator treated 87,875 tons of ore, producing 5,414 tons of concentrates, which were sent to the smelter, and 72,649 tons of tailings, which were treated in the leaching plant.

From these ores 5.7 per cent of our total copper production was obtained.

The sulphuric-acid plant supplied the leacher with 2,937 tons of acid.

These plants were closed down for the same reason as given for the curtailment of operations in other departments.

Including ores treated by the old smelter during the first quarter of the present period, a total of 182,873 tons of ores and concentrates were smelted during the year.

The average yield of copper from this material was 10.65 per cent.

After the first few months of breaking in the new smelter, during which time adjustments were being made and construction work completed, the plant has operated smoothly and well.

Two out of the three reverberatory furnaces were kept in commission until the end of August, since which time only one has been in continued operation.

The Shannon mine[2] and smelter were closed in August, the only property to cease operations in the district.

The annual report of the company says:

During the nine months' operation in 1914 the company treated at its smelter at Clifton, Ariz., 154,300 tons of ore from its Shannon property at Metcalf, Ariz., and 38,997 tons of ore from its various outside claims, and produced 9,003,169 pounds of fine copper, 1,295.425 ounces of gold, and 60,603.310 ounces of silver. Average copper extraction for the period covered by this report was 52.76 pounds per ton of ore from the Shannon mines proper and 16.68 pounds per ton of ore from the company's outside properties.

The average cost per pound of copper produced, delivered, and sold in New York was 12.26 cents. This is a reduction of about 1¼ cents per pound from the cost of production during the preceding 16 months. The average price

[1] Arizona Copper Co. Ann. Rept. for year ending Sept. 30, 1914.
[2] Shannon Copper Co. Ann. Rept. for year ending Dec. 31, 1914.

received for copper produced during this period was 13.6263 cents, as against 15.869 cents during the preceding 16 months. * * *

Due to the low metal price last year and to the necessity of discontinuing production last September, the usual amount of exploration work was not carried on during last year; in consequence of which there were little, if any, new developments of importance. We did, however, continue experimenting with our leaching process during the period when the property was not producing, and we now feel reasonably certain that the leaching process will work out satisfactorily on both the mill tailings and on the low-grade oxidized ore, of which the company has a large tonnage.

Placer bullion was produced from San Francisco River on the Frisco and Gold Coin placers.

MARICOPA COUNTY.

Twelve producers reported the output in 1914 of 39,440 tons of ore, 5,176 tons more than were reported by 21 producers in 1913. The total average value per ton decreased from $18.76 in 1913 to $14.39 in 1914, and the gold and silver value per ton in this ore from $17.91 to $13.89. Of the total output of ores, 38,933 tons were of milling grade and produced gold and silver bullion and lead concentrates, which contained a small quantity of copper and silver and good values in gold. Only 95 tons of ore containing gold, silver, and copper were shipped to the smelter. The total value amounted to $567,632, a decrease of $74,814 from that of 1913. The reports of placer operators showed $1,560 in gold and 7 ounces of silver, against an output in 1913 of $1,068 in gold and 3 ounces of silver.

Agua Fria district.—Gold and silver ore from the Relief mine was treated at the 50-ton dry crushing mill on the property, equipped for the treatment of ore by cyanidation, and yielded gold and silver bullion. Some defects in the plant caused delays, thus reducing the yield that might have been made from the property. The mine is opened by an incline shaft 500 feet deep.

Eagle Eye district.—Two small shipments of gold ore were loaded on the cars at Aguila and shipped to the smelters from prospects in the district.

Magazine district.—Small shipments of oxidized copper ore carrying silver were made from two properties in the district. The Red Rover property was operated a short time.

Salt River district.—The Delta property was under development during 1914, and some iron sulphide ore carrying good values in gold was shipped to the smelter as a test. The property is opened by an incline shaft 500 feet deep and has 300 feet of crosscuts in the lowest level.

San Domingo district.—Operations of dry placers in the district aggregated a production of $1,457 in gold and 6 ounces of silver.

Vulture district.—The largest part of the district output in 1914 was from the Vulture mines; there were also four other small producers of gold and silver ore. The ores of the Vulture mine contain gold, silver, copper, and lead, and a good percentage of each metal is recovered in the 20-stamp amalgamation, concentration, and cyanidation mill. The property is opened by an incline shaft 800 feet deep and vertical winzes 550 feet. There were 6,911 feet of development work done in 1914. The property and mill are fully described in Mineral Resources, 1913, Part I, page 695.

MOHAVE COUNTY.

Number of producers, ore sold or treated in Mohave County, Ariz., in 1904–1914, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	13	47,520	$563,824	86,782	1,420	6,036	.....	$613,956
1905	21	52,712	543,090	73,536	30,399	112,266	.....	597,525
1906	27	64,832	641,034	145,179	315,992	904,399	.....	850,841
1907	49	68,887	585,383	80,897	601,210	1,229,654	.....	825,997
1908	42	76,708	295,736	39,427	345,491	254,013	505,133	396,646
1909	30	30,822	[a] 356,367	[a] 79,665	313,384	113,406	5,264,121	727,666
1910	40	99,283	1,145,025	112,445	529,753	740,091	5,474,046	1,601,183
1911	47	140,402	1,547,666	143,969	244,378	2,591,589	4,476,552	2,026,300
1912	40	202,937	[a] 1,899,131	[a] 174,347	644,145	1,937,031	8,304,462	2,772,810
1913	44	206,239	1,874,547	246,707	747,620	5,315,646	7,031,400	2,767,083
1914	43	204,004	1,891,214	170,845	760,678	3,718,057	9,553,050	2,719,070
Increase (+) or decrease (−) in 1914	.....	−2,235	+16,667	−75,862	+13,058	−1,597,589	+2,521,650	−48,013

[a] Includes small placer production.

Forty-three producers, 1 less than in 1913, reported an output of 204,004 tons of ore, a decrease of 2,235 tons. The total average value per ton of this ore decreased from $13.42 in 1913 to $13.33 in 1914, and the gold and silver value from $9.81 to $9.73. The total value of the ore produced amounted to $2,719,070, or $48,013 less than in 1913. This total value includes $1,891,214 in gold, against $1,874,547 in 1913, an increase of $16,667. The silver decreased in value from $149,008 to $94,477; the copper from $115,881 to $101,170; and the lead from $233,889 to $145,004. The zinc increased both in quantity and in value, from $393,758 in 1913 to $487,205 in 1914. Of the county output of ore, the larger part was treated at milling plants by cyanidation and concentration. Mills using the amalgamation process produced 67.99 ounces of gold and 39 ounces of silver from 209 tons of ore. Two of the amalgamation mills were also equipped with concentrators, by which some gold, silver, and lead concentrates with high values in gold were recovered. The larger part of the ore produced in the county, amounting to 161,061 tons, was treated at 6 cyanidation mills, from which was recovered 88,569.17 ounces of gold and 41,165 ounces of silver. The concentrating ores amounted to 35,188 tons and produced 18,473 tons of concentrates, against 35,145 tons of ore and 17,536 tons of concentrates in 1913. In 1914 the concentrates contained $48,532 in gold, 107,084 ounces of silver, 11,987 pounds of copper, 3,668,942 pounds of lead, and 8,933,760 pounds of zinc, valued in all at $708,054, or an average value per ton of $38.33. The crude ore shipped to smelters amounted to 3,106 tons, against 4,856 tons in 1913. In 1914 the shipping ore contained $10,389 in gold, 22,557 ounces of silver, 748,691 pounds of copper, 49,115 pounds of lead, and 619,290 pounds of zinc, valued in all at $155,939, or an average value per ton of $50.21.

Aubrey district.—Two producers, the Graystone and the Midas, reported the production of 18 tons of milling ore, from which gold and silver bullion was recovered by amalgamation and cyanidation.

Bentley district.—The Grand Gulch and the Savanic mines were the principal producers of copper oxidized ore in 1914. Included in the 1,473 tons of ore mined and shipped, valued at $95,522, or $64.85 a ton, is the production of the Copper Mountain mine, situated 40 miles east of the Bentley district at Copper Mountain, on the Kanab Plateau.

Cedar Valley district.—Lead ore, carrying good values in silver and a little gold, was concentrated at the Siamese and the Pittsburg properties, and the product was shipped to the Needles smelter. This property is opened by a vertical shaft 200 feet deep and is equipped with a 150-ton concentration plant, having a tube mill and Overstrom tables, which was operated until February 7, 1914. Some bullion and concentrates were recovered from a small test made of ore produced during development work on the property of the Yucca Mining Co. The property is opened by an adit and incline from the tunnel level to 700 feet below the surface. The mill contains 10 stamps equipped for amalgamation and concentration.

Cottonwood district.—An important output of copper ore, carrying silver and gold, was shipped from the Copper Giant property, which is under lease to the United Verde Copper Co. The mine is opened by a 550-foot shaft in the vein with drifts on 6 levels. The work done so far shows the vein to be 4 to 8 feet wide, assaying about 2.5 per cent copper and $4 a ton in gold. The Lucknow and Music Mountain property under development is said to have opened some gold ore, which was the incentive for enlarging the mill now supplied with sufficient water by a 7-mile pipe-line. The renewed interest in the district has been the means of additional work on the Walkover property and the opening of the famous old Hackberry mine, in the Hackberry district, which is said to have produced over $3,000,000 in silver and whose old workings are reported to have been recently unwatered.

Gold Basin district.—Gold ore (carrying a little silver) from the Cyclopic mine, which is opened by a shaft 100 feet deep and 250 feet of drifts, was treated at the 20-ton cyanidation plant, which is equipped with a Chilean mill and with vats in which the ore is subjected to cyanidation by straight percolation.

Greenwood district.—There were two producers of ore containing gold and silver, the Bland and the Red Chief properties. The former property is equipped with an arrastre, in which the ore is crushed dry and treated direct by the cyanide solution. This property has been a regular producer for years, the operations being confined to the shallow surface workings.

Hackberry district.—A small test shipment of siliceous ore carrying good values in gold and a small percentage of silver and lead was made from one property in the district.

Maynard district.—The Windy Point property, situated on Lookout Mountain, was developed during part of the year and a small quantity of gold ore was treated in a 1-stamp mill equipped for cyanidation.

Owens district.—Two cars of oxidized copper ore, averaging 10 to 12 per cent copper and a little silver, mined in the course of assessment work, were reported to have been shipped from the Blue Bell property. At another property some old tailings were cyanided and produced silver with some gold.

San Francisco district.—Ten producers reported 160,469 tons of ore, carrying gold and silver values, from which was recovered in bullion, chiefly by the cyanide process, an average of $11.51 a ton in gold and silver. The principal producers were the Tom Reed and the Gold Road mines, and smaller productions were made from the Gold Crown, Ruth, and London properties. Considerable testing was done on a number of other properties.

The Tom Reed[1] management reports conditions at the mine and mill for its fiscal year as follows:

> The tons of ore milled during the year total 46,995. This is slightly lower than the tonnage milled the year previous, but considerably above the average for the series of years since the 20-stamp battery has been in operation. Last year's average per stamp was 7 tons for every day in the year. * * *
>
> The total gross recovery of gold from start of operation to April 1, 1915, amounts to $5,171,831.49, or a yearly average of $739,690.21 per a period of seven years. Last year the gross production was $1,002,406.60. * * *
>
> The ore milled during the year was mined largely below the seventh and eighth levels, with some ore taken from the seventh level stopes. At the end of the fiscal year ore was being drawn from the 350, 850, and 950 levels, with a small amount from pillar above the 550 level; there is still a good stope of ore 100 feet long and 5 feet wide above the 350 level from which ore is being drawn.
>
> The mill operated continuously during the year, except for infrequent shutdowns for minor repairs, the average extraction for the year being 96.2 per cent on a tonnage of 46,995 tons treated. The total recovery will eventually be augmented to the extent of approximately $16,000 recovered from scrapings from tailing pile. * * *
>
> Between the 950 and [the] 1,075 foot levels there has been a marked change in the character of the wall rocks inclosing the vein. Heretofore the footwall of the vein has been remarkably solid and free from fractures and brecciation; such, however, is not the case on our lowest level. There the footwall from the winze to the ore body was highly brecciated and showed unmistakable signs of intense crushing forces, the major cleavage planes dipping in an opposite direction to those of the overlying rocks. This disturbance did not in any way affect the dip of the vein nor did it modify the character of the ore, either as to structure or average values. The footwall in the lowest level is separated from the ore body by a well-defined clay seam; this occurrence has never been noted elsewhere in our properties. * * *
>
> Mineralogically, there is no difference between the rocks of our lowest level and those above; the difference is one of structure, being much finer grained.
>
> The survival of the ore body through this change in country rock gives much encouragement for the outcome of future explorations in depth. During the year, elsewhere in our vicinity, there have been discovered ore bodies far in the hanging wall country from any known outcropping vein, the outcrop being buried by flows of later date than the chloritic andesite.

The Gold Road mines[2] produced 107,846 tons of ore, which was treated in the mill of the company. Much development work was performed. Some profitable ore has been found, but in general the values have continued low. Propecting is being continued mainly in the upper levels, with rather indifferent results.

Wallapai and Union Basin districts.—Seventeen producers reported the output of 40,517 tons of ore. This includes the output of the Golconda property, situated at Union Basin. The district production amounted to $57,331 in gold, 123,365 ounces of silver, 18,297 pounds of copper, 3,708,102 pounds of lead, and 9,553,050 pounds of zinc, estimated as spelter, having a total value of $759,806, and an average value per ton of $18.75. Of the total ore mined in the district, 35,028 tons were concentrated and produced 18,428 tons of

[1] Tom Reed Gold Mines Co. Ann. Rept. for year ending Apr. 1, 1915.
[2] United States Smelting & Refining Co. Ninth Ann. Rept., for year ending Dec. 31, 1914.

concentrates, principally lead and zinc. Ore of shipping grade amounted to 1,153 tons containing gold, silver, copper, lead, and zinc. A small quantity of bullion was recovered from ore and old tailings.

Most of the ore treated at the concentrating plant at Needles, Cal., originated in the Tennessee mine at Chloride operated by the Needles Co.[1] under bond and lease.

Production of ore was reported from the Tennessee, Distaff, Badger, Pinkham, Detroit, Lucky Boy, Mohawk, New Jersey, White Elephant, and Golconda mines.

PIMA COUNTY.

The output of 9,657 tons of ore reported by 28 producers in 1914 was 12,709 tons less than was reported in 1913 by 45 producers. The total output in 1914 included $2,404 in gold from deep mines and $7,423 in gold from placers, 46,782 ounces of silver, 912,652 pounds of copper, and 769,145 pounds of lead, valued in all at $187,078. No zinc ore was reported in 1914. Nearly all of the ore produced, or 9,637 tons, was shipped directly to the smelters, and the remainder was treated in a gold and silver mill, producing some gold and silver concentrate.

Ajo district.—Important developments which will tend to make the district rank as one of the great producers of copper from low-grade ores have been carried on at the New Cornelia property during 1914. Water was developed and a 1-ton test plan was operated during the latter part of 1914 on the property.

The geology of the district, along with the history and development of the Cornelia property, was recently described by Mr. Joralemon,[2] the geologist of the Calumet & Arizona Mining Co. Extracts from his description follow:

The disseminated ore body.—The mineralization has formed a low-grade disseminated copper deposit, together with higher-grade veins in the monzonite and narrow rich veins in the adjoining rhyolite. * * *

The disseminated sulphide is chalcopyrite and bornite. Within the limits of the ore body the monzonite is shattered by a network of fractures. * * * The sulphides were introduced with the quartz in seams or films along the fractures and in small flakes disseminated in the porphyry. In general, a mixture of vein and disseminated material is required to bring the ore up to grade. In the main part of the ore body pyrite is present in small quantities only. Chalcocite is rarely found except in thin films just below the water level. * * *

Along some of the larger fractures sulphide seams widen to an inch or more, and several of these close together will form a band of ore 10 to over 100 feet wide, running from 3 to 5 per cent in copper. In general, the grade of ore is subject to abrupt changes, the richer portions being found in the more thoroughly fractured part of the monzonite. The bands of rich and lean material follow in general the fracturing in the vicinity. The rich bands are so narrow and irregular as to prohibit economical sorting, and the whole mass has to be considered as low-grade ore. * * *

Boundaries.—The boundaries of the ore body are commercial. Toward the southwest it extends to the rhyolite contact, and in some places the rhyolite is mineralized sufficiently to form commercial ore, but it is generally under 1 per cent and not commercial. To the east the change from ore to lean material is not so much the result of a decrease in mineralization as it is of a change

[1] Needles Mining & Smelting Co. in U. S. Smelting & Refining Co. Ninth Ann. Rept., for year ending Dec. 31, 1914.

[2] Joralemon, I. A., The Ajo copper mining district: Am. Inst. Min. Eng. Trans., vol. 49, pp. 593–609, 1914, and in condensed form in Eng. and Min. Jour., vol. 98, pp. 663–665, Oct. 10, 1914.

from copper sulphide to pyrite, together with a decrease in the amount of silicification and an increasing prevalence of the dioritic type of monzonite. To the west and northwest the changes from ore to lean material is caused by a decrease in mineralization all around. Where the bottom has been found, the ore gives place to less fractured and less silicified monzonite containing little copper sulphide. Occasionally a sudden change to a more acid and a more basic variation of porphyry is accompanied by a drop from ore to lean material. * * *

Surface alterations.—The result of alteration by surface waters, unlike those in other low-grade copper districts, has resulted in the formation of malachite, limonite, hematite, and a little chrysocolla. The rock is still hard, although the feldspar is somewhat kaolinized. The prevailing color is a deep red brown, due to staining by iron oxide, although brilliant copper staining can be seen in places. Probably over 85 per cent of the copper in this oxidized zone is in the form of malachite. Some disseminated sulphides are found in hard ores between fractures, but these are relatively unimportant. As in the sulphide zone, values vary greatly, and rich and lean bands alternate. Along large fractures some softening and leaching is found, with less copper in the adjoining harder rock. But more usually the variation in value is not accompanied by any change in the degree of alteration of the rock. The general copper content from top to bottom of the oxidized zone is constant, and is almost exactly the same as that of the underlying sulphide zone.

Sharp demarcation.—The bottom of the oxidized zone is almost a horizontal plane lying about 20 feet below the deepest arroyos and 150 feet below the highest hills, and this plane of demarcation agrees almost exactly with the present ground-water level. The transition from carbonate to sulphide is abrupt; less than 5 feet of material, whose classification is doubtful, is usually shown by the drill cores, although along large fractures bands of carbonate and sulphide ore may alternate over a distance varying from 15 to 20 feet vertically. Nor is there any appreciable enrichment of the top of the sulphide zone except for a few local exceptions. This abrupt change on a horizontal plane will greatly simplify both mining and treatment of the ore.

Rich veins in rhyolite.—The low-grade ore body just described was not what first attracted attention to the district; this was rather the existence of rich veins in the surrounding rhyolite. These vary in width to 6 feet and carry malachite, cuprite, chalcocite, and bornite. They are associated usually with dikes of monzonite, which themselves are frequently mineralized up to 2 or 3 per cent. In one or two places, lenses of this disseminated ore in monzonite dikes accompanying veins reach a width of over 50 feet and promise to yield a good tonnage. The development has not yet been carried far enough to show their ultimate importance.

According to Mr. Joralemon's estimate the ore developed as available by steam shovel amounts to 32,481,200 short tons carrying 1.54 per cent of copper.

Mr. Jovalemon adds:

The gold and silver content is low, generally amounting to less than 15 cents per ton. * * *

As for water, two deep wells were drilled in the large valley northeast of Ajo, and water was found in both at a depth ranging from 550 to 750 feet. * * *

As for the railroad, preliminary surveys have been made both from Gila Bend, on the Southern Pacific, and from Tucson, the junction point of the Southern Pacific and the El Paso & Southwestern systems. The respective distances are 44 and 130 miles. * * *

The ore body already developed will supply a 4,000-ton mill for over 26 years, or a 6,000-ton mill for over 18 years.

Amole district.—One small shipment of copper ore was recovered from a prospect in the district in 1914.

Prospecting with the diamond drill was continued on the Amole copper property.[1]

[1] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

The annual report of the Calumet & Arizona Mining Co. says:

This property, 9 miles south of Tucson, in Pima County, Ariz., was thoroughly prospected by diamond drilling. Work was started January 15 and stopped April 1. Five holes, totaling 1,500 feet, were drilled. The mineralization in this ground is similar to that at Ajo, but is not so intense. All of the holes showed appreciable values in copper, but not enough to make commercial ore.

Arivaca district.—Ore carrying values in gold and silver and a small quantity of lead and copper was shipped from one property in the district in 1914.

Baboquivari district.—A small quantity of ore was shipped from three properties in the district. The principal production came from the Papago Chief property, which produced ore carrying copper, silver, and gold, and from the Pico de Oro property. A great drawback to the district is that it is 65 miles southeast of Tucson, and transportation is very costly. It is reported that there is a wide area of gold-bearing schists which have yielded good values at different times.

Cababi district.—One small shipment of oxidized copper ore, containing silver and a trace of lead, was shipped from a prospect in the district operated by the Afro-American Development Co.

Greaterville district.—The output of placer gold in the district, largely from Mexican dry washing machines, aggregated $2,393. The entire output was reported by storekeepers who purchased the gold.

The Greaterville Dredge Gold Mining Co., holding 1,980 acres of placer ground, is reported [1] to be completing a well which is expected to supply sufficient water for a dredge.

The district is described by Hill,[2] who gives its geology and early history.

Helvetia district.—Sulphide copper ore was shipped from the Tip Top group and some copper-lead ore carrying silver from the Forst claims. The geology and description of the ore deposits are given by Schrader [3] in a recent report.

Indian Oasis district.—Placer bullion, said to have been produced in the district, amounted to $5,006 in gold and 38 ounces of silver.

Pima district.—Sixteen producers reported the output of 9,335 tons of ore of shipping grade, carrying $1,091 in gold, 43,128 ounces of silver, 872,699 pounds of copper, and 767,960 pounds of lead, valued, in all, at $170,960, or an average value per ton of $18.31. The largest producer was the San Xavier mine, whose output was copper ore and copper-lead ore. Important production was also made from the Red Carbonate, Minnie, Twin Butte, and Blanche Rose properties.

Quijotoa district.—No placer production was reported from the district in 1914, and only a small quantity of ore treated and concentrates were shipped from one property in the district. Low-grade ores, of which there is said to be an abundance, are without commercial value when the wagon-haul cost of $12 to $15 a ton is considered.

Silver Bell district.—Copper ore carrying small values in silver was shipped from two properties in 1914.

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[1] Min. and Sci. Press, Jan. 2, 1915, p. 45.

[2] Hill, J. M., Placer deposits of Greaterville, Ariz.: U. S. Geol. Survey Bull. 430, pp. 11–22, 1910.

[3] Schrader, F. C., Mineral deposits of the Santa Rita and Patagonia mountains, Ariz.: U. S. Geol. Survey Bull. 582, pp. 92–141, 1915.

PINAL COUNTY.

Nearly all of the ore credited to this county is that of one producer. The aggregate output of 27 producers was 2,462,459 tons, 83,636 tons greater than the output of 18 producers in 1913. The total average value per ton of the ore decreased slightly from $3.72 in 1913 to $3.32 in 1914, and the gold and silver value in this ore from 7 cents to 6 cents a ton. Of the ore produced in the county, 2,448,628 tons were concentrated, producing 154,377 tons of copper concentrate. There were also 9,493 tons of ore shipped directly to smelters containing 230.68 ounces of gold, 61,842 ounces of silver, 2,070,525 pounds of copper, and 33,234 pounds of lead, valued in all at $315,644, or an average value per ton of $33.25. In 1913 the shipping ore aggregated 7,051 tons, valued at $362,943, or an average value per ton of $51.47. Of the crude ore shipped to smelters, 68 tons was dry or siliceous ore carrying gold and silver and a small quantity of copper, 9,388 tons were copper ores, of which 4,073 tons were oxidized and 5,315 tons were sulphides; only 36 tons were lead ore, of which 28 tons were oxidized. There were treated at gold and silver mills 4,336 tons of ore producing 1,937.48 ounces of gold and 422 ounces of silver. Placer bullion amounting to $503 in gold and 5 ounces of silver was produced in 1914, against $1,106 in gold and 8 ounces of silver in 1913.

Bunker Hill district.—Copper ore was mined from the property of the Calumet & Copper Creek Mining Co. and concentrates were shipped in 1914. The company became bankrupt, and in June the property was closed. A small shipment of copper-lead ore was made from the Copper Carbonate group.

Casa Grande district.—An increased quantity of ore was shipped from this district in 1914. There were 7 producers who had an output of 335 tons of ore, containing $436 in gold, 4,912 ounces of silver, 34,147 pounds of copper, and 8,856 pounds of lead, valued in all at $8,039, or an average value per ton of $24. All of the ore was of shipping grade and came principally from the Silver Reef property, which produced oxidized copper ore and lead ore. Smaller shipments were reported from the Reward, Republic, Lake Shore, and Big Arizona properties.

Goldfield district.—Production of ore was reported from three properties in the district in 1914. The largest producer was the Mammoth group of the Young Mines Co., which recovered gold and silver bullion in a 10-stamp 50-ton cyanide mill on the property.

Mammoth district.—Prospecting with the diamond drill was carried on in 1914 on the Copper Giant property.[1]

The company's report says:

> In January diamond drilling was begun on these claims. Ten holes aggregating 3,610 feet were drilled before work was discontinued on August 25. Although the holes were drilled in the most promising parts of the property, no ore of commercial value was found.

Mineral Creek or Ray district.—A full review of the causes for curtailment in 1914 is given in the report of the company operating the Ray mines,[2] from which the following paragraphs are taken:

> The commercial and financial derangement following the outbreak of the European war * * * interfered abruptly with what promised to be a most

[1] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[2] Ray Consolidated Copper Co. Ann. Rept. for year ending Dec. 31, 1914.

prosperous year for your company. During the first seven months of the year the plants were running at approximately full capacity, the copper metal market was good and earnings were heavy. As more than half our output was marketed abroad, however, it was decided instantly to curtail production to 50 per cent of normal, when the sweeping character of the war became evident, and this curtailment continued through the remaining five months of the year. In the absence of any historical precedent it was impossible to forecast the percentage of normal copper consumption which would continue and the percentage which would be replaced by the demand of copper for war purposes. The last three months of the year, however, showed that the demand for the metal for both classes of consumption was very substantial and was steadily increasing. It may be added that during the months since the close of 1914 still further marked improvement has developed. * * *

A total of 59,044,700 pounds of copper were produced during the year in concentrates and high-grade crude ore shipments. After deducting smelting losses there were left 57,004,281 pounds. The average gross price of copper sold during the year was 13.41 cents per pound, or after deducting delivery charges a price of 13.26 cents. * * *

The tonnage mined from the beginning of operations to the end of 1913 was reported as being 4,613,402 tons. During the year's operations there were mined 2,429,330 tons of ore, consisting of 2,426,739 tons of concentrating ores, averaging 1.7604 per cent, and 2,591 tons of ore averaging 11.867 per cent, which were shipped direct to the smelter. The total tonnage mined from inception to the end of December, 1914, including 19,089 tons constituting the original reserve in Hayden ore bins, is 7,061,821 tons, averaging 1.74 per cent copper. In addition to this tonnage produced from regular operations, there were shipped by lessees 3,667 tons of carbonate ore, averaging 5.574 per cent of which no account was taken in the above figures. The total shipments to date of this class of ore are 5,050 tons, averaging 5.826 per cent copper. This carbonate ore is not considered when referring to tonnage of concentrating ores because it has not been taken into account in ore reserves, consisting as it does of small deposits scattered about the surface. * * *

The total ore milled for the year was 2,427,700 tons, corresponding to a daily average of 6,651 tons as compared to 2,365,296 tons for 1913. If the plant had operated during the last two quarters at the rate attained during the second quarter the year's tonnage would have been 3,006,129, indicating a possible increase over the previous year of over 27 per cent. The total tonnage of ore milled since the beginning of operations to the end of the year 1914 was 7,040,391 tons averaging 1.7348 per cent copper. The average copper content of the ore milled for 1914 was 1.76 per cent as compared with 1.719 per cent for 1913. The average recovery was 67.88 per cent, corresponding to 23.9 pounds of copper per ton, as compared with an average extraction of 66.09 per cent, corresponding to 22.723 pounds, for the previous year. The increase in extraction is the direct result of the improvements made during the year and would have been greater still but for the derangement of operations due to the 50 per cent curtailment of output during the last five months of the year. In order to keep the organization as nearly as possible intact employees were, generally speaking, put on half time and allowed to work alternate days. This procedure seriously interfered with systematic operations and affected adversely both extraction and costs, notwithstanding which, however, both factors showed improvements over the previous year.

The cost of milling for the year was 49.88 cents as compared with 51.93 cents for the previous year.

Smelting of the Ray copper concentrate is done at the Hayden smelting plant, the property of the American Smelting & Refining Co. The plant was built in remarkable time—ground was broken for the construction on September 15, 1911, the first charges put in the furnaces on May 6 and the first copper poured on May 17, 1912. A full description[1] of the plant appears in a recently published article by R. H. Vail, from which the following extracts are taken:

The concentrates treated at Hayden vary from 18.5 to 20 per cent Cu., 28 to 32 per cent insoluble, 22 to 25 per cent Fe, 25 per cent S, 1 per cent CaO,

[1] Vail, R. H., Smelting Ray concentrate at Hayden, Ariz.: Eng. and Min. Jour., vol. 98, pp. 553–558, Sept. 26, 1914.

5 to 5 per cent Al_2O_3. A considerable proportion of the concentrates is fine, and with the slimes, which are high in silica, have a tendency to form on the surface of the reverberatory furnaces an infusible siliceous blanket, which is difficult to flux.

The Ray concentrates are received in 60-ton gondola cars and are unloaded by hand and shovel sampled. The shovel sample, every tenth shovel full, is thrown into a small tramcar that runs alongside the railroad track and discharges the sample on a coning floor under the trestle track. Here the sample is coned at a convenient time and removed to an adjacent sample-grinding room. Limestone and flux are crushed and sampled in the limestone-crushing plant. * * *

A system of three 20-inch Robins conveyors transfers the concentrates, lime rock, and converter flux to the roaster building. * * *

The roaster building is a 4-story structure, 233 feet long by 48 feet wide. It contains 8 McDougal roasters; 3 of these are Allis-Chalmers furnaces, 19 feet 6 inches in diameter, having 6 hearths; the other 5 furnaces are 24 feet in diameter and have 5 hearths. * * *

One oil burner is used in each McDougal furnace, being placed at the door on the fourth floor. Oil is used intermittently for 15 or 20 minutes and then perhaps not for two or three hours, as it is not desired to burn off much of the sulphur. The aim in the roasting plant is to reduce the sulphur from 25 per cent to 12 or 14 per cent. The warmest hearth here is the bottom one, though the temperature in the roaster is low, speaking generally. The oil consumption varies from 3 to 4 gallons per ton treated. * * *

The reverberatory building is of steel and covers an area of about 127 by 160 feet. It contains at present 2 reverberatory furnaces, 19 by 112 feet, and also houses six 350-horsepower waste-heat Stirling boilers. At the other end of the reverberatory buildings are 3 converters, arranged in a converter aisle at right angles to the axes of the reverberatories. * * *

The furnaces are oil fired, 5 burners of the Steptoe type being provided, although only 3 of these are ordinarily used. * * *

The capacity of the reverberatory furnaces has been as high as 350 to 400 tons per day for 10-day periods, making 40 to 42 per cent matte, and slag running from 43 to 45 per cent SiO_2, 28 to 30 per cent Fe., and 7 to 10 per cent CaO. Lime flux is added to make the slag more fluid; when the CaO falls below 7 per cent the slag loss seems to increase. * * *

The converter aisle is 256 feet long by 60 feet wide. It contains two Pierce-Smith converters and a 12-foot Great Falls type converter, added last summer. The converters are electrically operated and are served by a 60-ton Morgan crane, the crane rails being 40 feet above the floor.

Old Hat district.—Bullion said to have been produced from ore treated in the district was reported by 2 producers in 1914. Producers of placer gold reported $503 in gold and 5 ounces of silver.

Pioneer and Silver King districts.—There were 6 producers shipping ore from the district in 1914. The largest output of crude ore and concentrates was made by the Magma Copper Co., operating a 150-ton concentration plant. The prospecting work on the Daggs-Newman group[1] of claims proved disappointing.

The annual report of the Calumet & Arizona Mining Co. says:

> At the Tener shaft on the Daggs-Newman group of claims in the Pioneer mining district, 3,515 feet of development work was done during the year. The greater part of this work was done on the 500 and 700 foot levels. While the vein on the 500-foot level showed no ore, some very favorable ground was encountered which gave encouraging prospects for the lower level. Development work on the 700-foot level proved disappointing, however, and did not justify an extension of the option. Operations at this property were discontinued July 28, and all supplies and equipment, including electric power line, were shipped either to Bisbee or Ajo.

A small quantity of ore was shipped from the Silver King property which carried high values in silver with a little lead.

[1] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

Priorwood district.—Considerable shipments of copper oxidized ore, taken from the Soldier Boy claim, were made to the smelter at Hayden. The property is opened by a vertical shaft 225 feet deep and has 1,200 feet of drifting.

Riverside district.—Three producers reported the mining of 631 tons of ore carrying gold, silver, and copper. The larger part of the ore was concentrated in the new 150-ton concentration plant of the Kelvin-Sultana Mining Co. In addition to the concentrates produced, there was some crude ore shipped directly to the smelters by this company. The property is opened by a shaft 500 feet deep and has about 200 feet of drifting. The mill was completed and given a trial run in November, after which the property was closed to the end of the year on account of the low price of copper.

Saddle Mountain district.—The Hoosier group, situated on Ash Creek, produced one lot of siliceous gold ore carrying a trace of copper.

SANTA CRUZ COUNTY.

The output of ore reported by 34 producers in 1914 amounted to 12,823 tons, which was 9,839 tons less than was reported by 40 producers in 1913. The total average value of the ore increased slightly, from $31.26 in 1913 to $31.96 in 1914, and the gold and silver value in this ore from $2.76 to $6.02 a ton. The total value of the county output, including some placer bullion reported from one source, amounted to $410,082, of which the gold was valued at $6,569; silver, 128,270 ounces, at $70,934; copper, 2,337,480 pounds, at $310,885; lead, 403,272 pounds, at $15,728; and zinc, 116,983 pounds, at $5,966. The ore shipped directly to the smelters amounted to 11,823 tons and contained nearly all the copper and the larger part of the lead and zinc, with gold and silver values in addition, and had a total value of $401,788, or an average value per ton of $33.98. The larger part of the ore (10,068 tons) was copper sulphide, and 131 tons were copper oxidized ore. There were also 1,124 tons of oxidized lead ore, 199 tons of dry or siliceous ore, 19 tons of zinc ore, 111 tons of copper-lead ore (80 tons of which were oxidized), and 1,171 tons of lead-zinc ore.

The placer production amounted to $307 in gold and 2 ounces of silver.

Harshaw district.—Oxidized copper ore and lead ore were shipped to the smelter from the Flux and Hardshell properties and the World's Fair mine. The Harshaw district adjoins the Wrightson and Redrock districts on the south. It is about 5 miles wide and extends from Sonoita Creek, at Patagonia, 9 miles southeastward to a point 3 miles beyond Harshaw. Harshaw Creek marks the northeast boundary; Meadow Valley Flat, the east boundary; an east-west line passing just south of the American mine, the south boundary separating it from the Patagonia district; and the main ridge of the Patagonia Mountains to the west of Alum and Flux gulches, the west boundary, separating it from the Palmetto district.

The principal settlement is Patagonia, which is on the railroad and is a flourishing mining center with about 200 residents. It is the chief distributing and supply point for the district, as well as for a much larger surrounding region. Two daily passenger and mail trains stop here.

Harshaw, in the south-central part of the district, was also once a prosperous village and camp and has mostly stone buildings, but in 1909 only a few families were living there. The other principal camps are the Hardshell, World's Fair, Wieland, Elevation, Standard, and Thunder. A daily stage and mail service is maintained between Patagonia, Harshaw, Mowry, Washington, and Duquesne. The roads and trails in the district are good, and the mines and prospects as a rule are easy of access.

The topography is rough and much of it in the western part of the district, which lies in the Patagonia Mountains and rises to elevations of more than 6,000 feet, is rugged, of the type produced by erosion of volcanic rocks in an arid climate. Red Mountain, a castle-shaped mass in the north-central part of the district just south of Patagonia, attains an elevation of 6,350 feet, whence the surface declines to 4,500 feet in a radius of 2½ miles. South of Red Mountain and east of the Patagonia Mountains the elevations rise to about 5,000 feet. The drainage is principally northwestward into Sonoita Creek, by way of Harshaw Creek on the east and Alum Gulch on the west. Both streams flow through canyons in the middle parts of their courses.

The bedrock of the district comprises five or more formations, which, named in ascending order, are the Paleozoic limestones, quartz diorite, granite porphyry, rhyolite, and andesite. They are described in a recent report by Schrader,[1] who furnishes the paragraph above concerning the district and, in his report, follows it with the geology of the region.

Nogales district.—A small shipment of oxidized copper ore was made from one property in 1914. The district lies in the southwestern part of Santa Cruz County, on the border of Sonora. It adjoins the Palmetto and Patagonia districts on the west and extends from the international boundary 10 miles north to Sonoita Creek, and from Nogales Wash on the west to Santa Cruz River on the southeast. Nogales is at its southwest corner and Calabasas at its northwest corner. At the international boundary it has a width of 10 miles. Nogales is a port of entry between the United States and Mexico, and the principal supply point for northern Sonora and the adjoining region of Arizona. Calabasas is on the Benson-Nogales and Tucson-Nogales branch lines of the Southern Pacific Railroad, and the Pioneer smelter is located a few miles to the north.

Most of the country is less than 4,000 feet in elevation. The topography is rough, the surface being scored by deep gulches or shallow canyons. The highest point in the district is Mount Benedict, near the center of the western part, which rises to 4,500 feet. The surface, especially on the east and north, is mostly underlain by a sheet of Quaternary gravels and wash. The geology is given by Schrader,[2] who described the district in a recent report.

Oro Blanco district.—Nine producers in 1914 mined 234 tons of ore containing $2,485 in gold, 4,321 ounces of silver, 6,357 pounds of copper, and 12,851 pounds of lead, valued in all at $6,221, or an average value per ton of $26.59. A little more than half the ore was

[1] Schrader, F. C., Mineral deposits of the Santa Rita and Patagonia mountains, Ariz.: U. S. Geol. Survey Bull. 582, pp. 245–292, 1915.
[2] Idem, pp. 348–355.

treated at a gold and silver mill, producing bullion and concentrates containing gold and silver. The remainder of the ore was shipped directly to the smelters and contained all of the copper and lead, and also 68.11 ounces of gold and 4,287 ounces of silver. The principal producers were the Black Peak, Mina de Plata, Idaho group, Triangle, and Warsaw properties.

Palmetto district.—The principal output was from the Three R property, which produced a large quantity of copper sulphide ore carrying very little silver. A recent bulletin by Schrader [1] gives a description of the geology and the ore deposits within the district.

Patagonia district.—Nine producers shipped 2,448 tons of ore, carrying $292 in gold, 11,142 ounces of silver, 520,506 pounds of copper, and 2,537 pounds of lead, valued in all at $75,780, or an average value per ton of $30.96. The principal production of copper sulphide ore carrying silver came from the Duquesne property, which was operated up to August 7, 1914. The district is in Santa Cruz County, on the border of Sonora. It covers the southernmost part of the United States portion of the Patagonia Mountains and lies south of the Harshaw and Palmetto districts. It is about 12 miles broad from east to west and 8 miles from north to south. On the west, for 4 miles north of the Mexican line, the boundary of the district follows Santa Cruz River. On the east it roughly follows the upper or western edge of the wash or valley plain of the river, which toward the north coincides with the west or upper boundary of Meadow Valley Flat. The northern boundary, beginning on the west, follows the divide north of Canada de la Paloma to the crest of the Patagonia Mountains on American Peak, whence it continues eastward across the Harshaw Creek drainage basin to Meadow Valley Flat.

The principal settlements are Mowry, Washington, and Duquesne, all good-sized camps, located in the eastern part of the district. A daily mail and stage service is maintained between these camps and Patagonia on the railroad 16 miles to the north, which is the shipping point for the mines east of the main range. Washington and Duquesne also have intermittent stage service with Nogales, about 18 miles to the west. It is said that a new wagon road will soon be built from Patagonia to Washington and Duquesne, passing near the Three R properties, the Chief mine, and the Volcano group. This road will shorten the route to the railroad by several miles, and will give the mine owners an easy down grade for hauling their ore into Patagonia for shipment.

Mowry has a concentrating mill and smelter, and at Washington there is an elaborate concentrating plant and a 50-ton smelter.

Of the other camps in the district, Four Metals, O'Connors, and Benton are on the east side of the range, and Old Soldier, Gross, Golden Rose, and Buena Vista on the west side. Besides the mining camps there are many small ranch houses in this region. The roads and trails between the various parts of the district are good. A telephone line extends from Mowry to Patagonia and another from Washington and Duquesne to Nogales. Schrader,[2] who gives the location of the district, also describes the geology and the ore deposits.

[1] Op. cit., pp. 279–292. [2] Op. cit., pp. 292–348.

Tyndall district.—The output of 1,383 tons of ore mined in the district produced $2,473 in gold, 5,056 ounces of silver, 24,753 pounds of copper, 230,961 pounds of lead, and 116,983 pounds of zinc, having a total value of $23,535, or an average value per ton of $17.02. The larger part of the ore mined was milled and produced lead concentrate and lead-zinc concentrates carrying values in silver. The remainder of the ore (503 tons) was shipped directly to the smelters. The principal producer was the Elephant Head property, and smaller productions were reported from the Connecticut, Royal Blue, and Sheehy group. The Tyndal district, the largest and one of the most highly mineralized districts of the area, occupies the western slope of the southern half of the Santa Rita Mountains. It joins the Old Baldy district on the south and west and is almost wholly in Santa Cruz County. It extends from Madera Canyon, near White House and the county line on the north, southward to Sonoita Creek, a distance of 18 miles, and from the crest of the range on the east to the foot of the mountains and Grosvenor Hills, 6 miles distant on the west. Toward the south the crest of the range follows the ridge between Squaw Gulch on the west and Temporal Gulch on the east. The district contains about 110 square miles. A small part of it south of the Salero camp is still spoken of as the Aztec district, and includes the old Aztec mine and some of the surrounding country. Schrader,[1] who notes the general features of the district as given above, includes a description of the topography, geology, and ore deposits in a recent report.

Wrightson district.—All of the ore produced was shipped directly to the smelters and contained lead and copper, with values in silver and a little gold. The Blue Lead, opened by 4 tunnels, and the Lee mine by an incline shaft 460 feet deep, were productive. The Wrightson district adjoins the Tyndall district on the east, lying on the opposite or east slope of the southern part of the Santa Rita Mountains. It extends from Old Baldy Peak on the north and Adobe Canyon on the northeast to Patagonia, 12 miles distant, on the south; and from the crest of the range between the Arizona-Pittsburg and the Augusta mines to Sonoita Creek at the Pennsylvania ranch, 8 miles distant, on the east. Its southeastern boundary follows Sonoita Creek to a point 2¼ miles below Patagonia, where it meets the western boundary, which follows the ridge between Temporal Gulch on the east and Squaw Gulch on the west. It is in Santa Cruz County. Patagonia is the post office and supply point for the district.

The topography is generally rough, of the eroded volcanic rock type, the surface being scored by many approximately parallel gulches or canyons, through which the drainage issues southeastward into Sonoita Creek and which render transportation transversely to their courses difficult. The largest of these canyons is Temporal Gulch, which heads on the south slope of Old Baldy a mile and a half from the peak, extends southward for 12 miles, and joins Sonoita Creek three-fourths of a mile below Patagonia. The topography, geology, and ore deposits are described by Schrader[2] in a recent report.

[1] Op. cit., pp. 180–220.

[2] Op. cit., pp. 220–239.

YAVAPAI COUNTY.

Number of producers, ore sold or treated in Yavapai, County, Ariz., in 1904–1914, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	34	439,622	$2,013,747	953,622	30,826,286	497,905	.....	$6,436,105
1905	39	364,697	1,391,070	783,707	34,279,734	697,806	.....	7,259,097
1906	46	396,788	1,256,623	708,439	42,080,740	729,787	.....	9,894,458
1907	117	375,398	1,144,102	647,488	35,734,416	521,307	140,786	8,754,263
1908	79	314,113	1,116,793	602,845	36,248,440	362,334	.....	8,236,207
1909	56	323,489	952,243	578,580	37,125,964	409,890	.....	6,097,105
1910	104	417,308	881,970	669,702	40,824,555	264,911	.....	6,456,184
1911	109	215,155	689,384	764,744	36,103,649	318,089	47,165	5,624,956
1912	108	406,053	482,501	718,872	34,043,005	481,827	292,705	6,502,032
1913	105	447,679	517,216	851,049	38,719,973	242,369	211,533	7,057,167
1914	100	459,982	557,064	786,917	34,057,952	169,959	.....	5,528,565
Increase (+) or decrease (−) in 1914	.....	+12,323	+39,848	−67,132	−4,662,021	−72,410	−211,533	−1,528,602

[a] Placer production included.

Eighty-one operators of deep mines and 19 operators of placers in this county produced an output in 1914 valued at $5,528,565. This was $1,528,602 less than the value of the output in 1913 reported by 105 operators of deep mines and placers. There were 459,982 tons of ore mined and treated, or 12,323 tons more than in 1913. The total average value per ton decreased from $15.74 in 1913 to $11.99 in 1914, and the gold and silver value in this ore decreased from $2.28 to $2.13 a ton. Of the total value of the metals recovered, $557,064 was for gold, $435,165 for silver, $4,529,708 for copper, and $6,628 for lead. No zinc was produced. Production of all the metals, with the exception of gold, decreased when compared with the output of 1913. Smelters in and out of the State treated 409,464 tons of crude ore, the larger part of which, or 381,322 tons, was copper ore. Of this ore, 365,320 tons were classed as sulphides and the remainder, 16,002 tons, was oxidized ore. There were 27,929 tons of dry or siliceous ore produced, and 213 tons of lead ore, largely oxidized. The total value of these ores treated at the smelters amounted to $5,038,206, or an average value per ton of $12.30. Concentrates amounting to 12,813 tons, derived from 46,996 tons of ore, were also smelted, and contained 2,059.45 ounces of gold, 44,789 ounces of silver, 2,917,945 pounds of copper, and 84,452 pounds of lead, valued in all at $458,722, or an average value per ton of $35.80. The ores treated at gold and silver mills amounted to 3,372 tons, and yielded $19,281 in gold and 215 ounces of silver. The placer output amounted to $12,190 in gold and 87 ounces of silver, as against a production of $10,210 in gold and 103 ounces of silver in 1913.

Agua Fria district.—A small quantity of oxidized copper ore was shipped from one property in 1914.

Big Bug district.—Twenty-one deep mines and 7 placers produced ore and bullion valued at $574,421. There were 56,690 tons of ore produced, the larger part of which was concentrated to 12,602 tons of concentrates, which contained 1,489.64 ounces of gold, 41,453 ounces of silver, 2,915,164 pounds of copper, and 22,283 pounds of

lead. The shipments direct to smelters amounted to 9,377 tons of crude ore containing 690.98 ounces of gold, 15,973 ounces of silver, 779,065 pounds of copper, and 4,276 pounds of lead. The greater part of the ore mined was from the Blue Bell mine and was shipped to the concentrator and smelter at Humboldt. There was also an important quantity of crude ore smelted directly from this property, which yielded copper with values in gold and silver. Ore was also reported from the Henrietta, Union, Lelan, Little Jessie, Poland, and Walter properties. Reports from purchasers of placer bullion and from placer operators indicate a production of $2,032 in gold and 11 ounces of silver in 1914.

Black Canyon district.—Gold-silver ore was treated from the Silver Tip property, and a small shipment was made to the smelters from the Silver Cord claims.

Blue Tank district.—One property produced oxidized copper ore carrying values in gold.

Castle Creek district.—A small quantity of gold ore produced some bullion, which was shipped from the district in 1914.

Cherry Creek district.—The larger part of the ore mined in 1914 from four properties was milled, producing gold and silver bullion and a small quantity of siliceous concentrate. There was also a small quantity of gold ore shipped directly to the smelter. The total production of the district was valued at $2,866. The Esmeralda property was leased and a small quantity of gold bullion was shipped. The Wymazona Co. was organized to operate a group of nine claims. The property is equipped with a 5-ton amalgamation and concentration mill.

Copper Basin district.—Three producers mined 2,727 tons of ore, all of which, with the exception of 60 tons, was shipped directly to the smelter and contained $549 in gold, 4,002 ounces of silver, 284,001 pounds of copper, and 9,488 pounds of lead, valued in all at $40,904, or an average value per ton of $15. The largest shipper of oxidized copper ore to the smelter was the Copper Basin mine, which is opened by a vertical shaft 600 feet deep, with numerous drifts and adits. The property was operated until August 21, 1914. Lead sulphide ore was produced from the United States Navy group and shipped to the Needles smelter. Gold and silver bullion was derived from ore treated in a 3-stamp mill on the Hub property.

Eureka district.—Three deep mines and two placers yielded ore and bullion valued at $10,952. The ore mined from three properties amounted to 388 tons and contained $8,816 in gold, 2,896 ounces of silver, 113 pounds of copper, and 4,037 pounds of lead, valued in all at $10,589, or an average value per ton of $27.29. The producers were the Hillside and Nieman and the Cyglance claims.

Hassayampa district.—The ore output of 15 deep mines was 1,371 tons, containing $15,069 in gold, 15,309 ounces of silver, 36,717 pounds of copper, and 69,938 pounds of lead, valued in all at $31,146, or an average value per ton of $22.72. The greater part of the ore, or 1,047 tons, was milled and produced bullion and lead concentrates. There were shipped directly to smelters 324 tons of ore, containing 258.27 ounces of gold, 13,365 ounces of silver, 34,939 pounds of copper, and 11,079 pounds of lead. The largest producers of milling ore were the Y. P. and Climax mines, both of which shipped gold and silver

bullion and concentrates. Ore of shipping grade was also produced from the Poverty, Little Johnnie, and White Spar claims.

Humbug district.—The greater part of the ore (163 tons) from seven deep mines was milled and produced gold bullion and concentrates. There were also 29 tons of ore containing lead shipped directly to the smelters. The total output of the district was valued at $2,567. Most of the ore was mined from the Occident and Centurion groups, producing gold and silver bullion. This property is opened by an adit 414 feet in length and is equipped with a 10-stamp amalgamation and concentration mill. The property was closed August 31. A small quantity of gold ore from the Crescent Queen and Gleimo groups was treated by amalgamation and cyanidation.

Martinez district.—Two producers mined 42 tons of ore containing gold and silver. The total output aggregated $3,122.

Old Tip Top district.—Silver ore was mined from the Alvarado and Security group in cleaning up the property, which was badly caved. The mine is opened by an adit 550 feet long.

Peck district.—All the ore produced from the Peck district in 1914, amounting to 112 tons, was shipped directly to the smelters, principally from the Silver Prince property, and contained silver with some lead and gold.

Tiger district.—All the ore produced in the district, amounting to 1,174 tons, with the exception of 7 tons, was milled and produced gold and silver bullion and some concentrates. The output was reported by seven producers and had a total value of $6,823, or an average value per ton of $5.82. The mine dump of the Crown King mine was operated under lease, and the ore was treated by amalgamation and concentration. The Gray Eagle mine of the Tiger Gold Co. was covered by a mortgage of $100,000, which was foreclosed during 1914. The mine has not been operated for two years, a little prospecting work excepted.

Turkey district.—Five producers shipped 17 tons of gold ore, silver ore, and lead ore, having a total value of $1,339, or an average value per ton of $78.76. The principal production came from the Thunderbolt claim.

Verde district.—All the ore produced in the district came from one property, the United Verde. This property is opened by several deep shafts and three adits 1,150, 1,950, and 6,700 feet long, with 25 miles of drifting. The ores are mostly sulphides, which were treated in the 1,000-ton smelter of the company at Jerome. The mine was operated throughout the year 1914. Arrangements were made for handling the ore through a system of raises and interior ore bins out through a tunnel to the new smelter at Clarkdale, 6 miles distant. In 1914 the old system prevailed of raising the ore through the shafts to the old smelter situated near the collar of the shafts. This property and its ores are fully described by Graton,[1] and also by Tupper,[2] who describes in detail the mine at Jerome and the new smelter at Clarkdale. Part of Tupper's description follows:

> The ore bodies of the United Verde mines are in the form of lenticular lenses and occur in a large shear zone of schist and porphyry. The country rock is diorite and the schist is an alteration of this rock. The porphyry is siliceous

[1] Graton, L. C., U. S. Geol. Survey Mineral Resources, 1907, pt. 1, pp. 597–598, 1908.
[2] Tupper, C. A., Mine and smelter of the United Verde Copper Co.: Min. and Eng. World, vol. 42, pp. 717–727, Apr. 17, 1915.

and is an intrusive in the schist. The ores are mostly chalcopyrite, except in the upper levels where considerable amounts of chalcocite, black oxide, and other secondary minerals occur.

There are three principal classifications of copper ore, according to the gangue rock. The first and most important is termed iron raw and assays from 32 to 40 per cent iron, 35 to 45 per cent sulphur, and from 4 to 10 per cent silica. The copper content varies from a low to high grade ore. There are immense lenses of low-grade iron pyrite enriched along the lines of contact of the schist and porphyry and along intrusions (locally termed "water courses") to commercial ore. These ore bodies extend to within 150 feet of the surface, over which oxide ores occur carrying good values in gold and silver and small values in copper. The second class of ores consists of chalcopyrite in a schist gangue, and these ore bodies extend almost to the surface with but little alteration or enrichment. The third class of ores are in a quartz and quartz-porphyry gangue and extend to the surface as an iron-stained quartz cropping. Portions of this latter class of ore are so siliceous that it is used for converter flux. Parts of the oxide ores overlying the pyrites are also sufficiently siliceous for use as converter flux. A large portion of the old iron sulphide ore bodies are in a fire district and are bulkheaded off from the remainder of the mine, except such portions of the fire area as is now being worked, as described below.

The oxidized ores of the outcrop, which carry high values in gold and silver, extend to the 160-foot level. These are now being mined in an open cut at the top and "milled" down to the 80-foot level, where small cars drawn by Jeffrey 4-ton electric locomotives take them to a loading station at No. 4 shaft. There the 3-deck cages are served by a 20 by 48 inch Allis hoist, with flat rope and reel, which is capable of raising the maximum load from a depth of 1,000 feet. It is also used for the ores recovered in the fire zone. The shaft has two compartments.

The "fire zone," which represents the older part of the sulphide workings and some of the stopes of the oxidized ore area—all lying above the 700-foot level—was started by a fire which broke out nearly 13 years ago and has smoldered ever since. The ore, being high in sulphur, burns easily. * * *

The principal operations of the company, however, are in the newer part of the mine, where levels have been opened up down to 1,500 feet, with a tunnel 6,600 feet long at the 1,000-foot level. The 300, 400, and 500 foot levels; also the 900, 1,000, and 1,200, are haulage levels, while the 1,350 and 1,500 foot levels will be. The total haulage equipment for all mine operations includes nine 4-ton, four 6-ton, and three 7-ton Jeffrey locomotives. * * *

The tunnel at 1,000 feet, which is now practically completed, opens on the mountain side directly opposite the new smelter built at Clarkdale. It is approximately 6,600 feet long, 12 feet bottom width, and 9 feet high, with a drainage way underneath. Ore from the bin sections or chutes at the side, which have a total capacity of 48,000 tons, are taken out into 5-ton, hopper-bottom, automatic dump cars and hauled on standard-gage tracks to loading bins and a sorting belt at the tunnel mouth by means of the Jeffrey electric locomotives mentioned. There the loads are transferred to 50-ton pressed steel cars, of which there are 30 now in service. * * *

For hauling the ore and flux from the mine to the reduction works a railroad has been built and organized by a separate corporation known as the Verde Tunnel & Smelter Railroad Co. This connects at Clarkdale with another standard-gage road, 39 miles long, built to a junction with the Santa Fe system at Glade, Ariz., displacing the old narrow-gage road from Jerome. * * *

Ore from the bins which does not require crushing is drawn out underneath to the charging cars through weighing hoppers. The larger portion, however, is carried by belt conveyors from the storage and bin conveyors to the crusher plant. There it discharges to an Allis-Chalmers 30 by 18 inch jaw crusher of the Blake type, driven by a 50-horsepower Westinghouse motor, the product of which passes up a long incline belt conveyor which [has a] capacity rated at 2,400 tons daily, 5 feet per second, to the top of the sampling mill.

This mill is arranged in the usual two sections, having three 20 by 10 inch Blake crushers, equipped, like the one mentioned above, with manganese steel jaw plates; three sets of Allis-Chalmers crushing rolls 54 by 24, 36 by 12, and 24 by 12 inches, the first named being of the Anaconda type; two 4 by 14 foot Gates trommels, with dust jackets and manganese steel coverings, and four Snyder samplers ranging in size from 60 to 27 inches, with 10, 20, 20, and 10

per cent cuts; so that the final sample is as 1 to 250. It passes at the end to a sample safe and steam driers in the laboratory department, where a small Blake crusher, Sturtevant rolls, and Denver Engineering Works sample grinders prepare it for testing. * * *

In the calcining plant the ore is fed to six 21½-foot Wedge furnaces, each of which has a capacity of 96 tons in 24 hours. The hearths, 6 roasting and 1 drying, are lined with concrete. * * *

The revolving mechanism of the furnace rests on roller bearings, and each is so nicely balanced that a man can turn a furnace. When the hearths are loaded the entire plant requires only a 30-horsepower, 440-volt Westinghouse motor for revolving all of the units. * * *

The calcines, with oxidized ores from the "outcrop" and "fire zone" of the mine, are fed to three 19 by 100 foot reverberatory furnaces, housed at one end of the furnace building in an area 145 by 113 feet. * * *

The converters, which are basic and lined with Harbison-Walker magnesite, consist of four stands with five 12-foot shells of the Great Falls type. * * *

The reduction works have been built on a site sufficiently above the channel of Verde River to give room for a slag dump and there is ample area for filling.

The smelter stack is 400 feet 1 inch high, with a 30-foot, 9-inch shell and 4½-inch brick walls, making it just 30 feet inside diameter for all above the 50-foot high flare or bell, which is 50 feet 9 inches at the base. * * *

Fuel oil for the smelting furnaces, and for the boiler furnaces when required, is unloaded from tank cars into a 10,000-barrel storage tank. * * *

Current from the transmission lines of the Arizona Power Co. enters through a substation at 44,000 volts, and is stepped down to the 2,200 volts of the works distribution in three 200-kilowatt Westinghouse water-cooled transformers. * * *

From an economic standpoint the new operations inaugurated at Clarkdale have great importance; for, besides handling the output of the United Verde mine, and later of the Copper Giant and Hackberry mines under the same interests, a large quantity of custom ore will be treated, thus facilitating copper mining in the entire district. Low-grade ore from both the Clark properties and others that could not heretofore be economically handled will also be smelted, thereby not only enlarging production but also bringing down average costs. The capacity of the plant will approach 3,000 tons daily, or more than double that of the old works.

Walker district.—The Blue John and Eureka properties were operated in 1914, the former producing ore yielding gold and silver bullion and also ore of shipping grade containing lead. The placer yield of the district, reported largely by purchasers of bullion, aggregated $3,720 in gold and 24 ounces of silver in 1914. Most of this gold was recovered from Lynx Creek and some of it from the Goldsworthy placer claims.

Weaver district.—Reports received from purchasers of placer bullion give the aggregate yield of the district as $4.199 in gold and 19 ounces of silver in 1914. Some of the gold is produced in the Weaver and Antelope gulches. It is possible that the 1914 reports of placer gold production are a little below what was actually produced, as some of the gold is said to have been sold outside of the district.

White Picacho district.—The Golden Rule and Producer groups produced gold and silver ore.

YUMA COUNTY.

Yuma County, with 26 producing deep mines in 1914, reported the output of 27,777 tons of ore, which was 4,620 tons more than was reported by 43 producers in 1913. The total average value per ton of this ore decreased from $8.25 in 1913 to $2.14 in 1914, and the gold and silver value from $2.51 to $1.30. The total value of the gold,

silver, copper, and lead produced was $64,890, as against an output of $200,786 in 1913. Included in the production in 1914 was $5,517 in gold and 45 ounces of silver recovered from 22 placer surface mines, as against $9,714 in gold and 88 ounces of silver produced in 1913. Most of the placer gold was reported from the Quartzsite region. Of the ore, 737 tons were shipped directly to smelters, and contained 256.42 ounces of gold, 5,056 ounces of silver, 119,359 pounds of copper, and 136,578 pounds of lead. There were also 35 tons of concentrate shipped, carrying gold, silver, and lead, which was recovered from 400 tons of ore. At gold and silver mills 520 tons of ore and 26,120 tons of old tailings produced 1,233.29 ounces of gold and 3,445 ounces of silver.

Castle Dome district.—Four deep mines and 3 placers produced ore and bullion containing $7,169 in gold, 5,948 ounces of silver, and 169,055 pounds of lead, valued in all at $17,051. The ore produced amounted to 735 tons and averaged $21.28 a ton. Part of the ore was milled and produced gold and silver bullion in a 2-stamp cyanide mill on the Big Eye claim. Lead concentrates were shipped from the Chief of the Dome property, which is equipped with a Stebbins dry concentration mill. Shipments of lead ore were also made from the Lady Edith property. Placer bullion amounting to $1,409 in gold and 7 ounces of silver was reported from three sources.

Ellsworth district.—Ore and old tailings aggregating 26,426 tons and placer mines produced $19,365 in gold, 681 ounces of silver, 11,611 pounds of copper, and 3,296 pounds of lead. The lead and copper was contained in ore shipped directly to the smelters. The larger part of the gold bullion produced came from tailings from the Bonanza and Golden Eagle property, reworked by the 40-stamp amalgamation and cyanidation mill. There was also some ore treated from the Socorro mine in its 20-stamp mill and 50-ton cyanidation plant, which produced gold and silver bullion. Ore of shipping grade containing copper was produced from the Vesuvius property and the D. and D. claims. Placer bullion containing $216 in gold and 2 ounces of silver was reported in 1914.

Fortuna district.—In making a test on some ore from the Old Fortuna mine a small quantity of gold bullion was recovered. This property is 22 miles southeast of Yuma at the foot of the eastern slope of the Gila Range. After lying idle about 10 years it was again opened in 1914. The mine is reported[1] to have produced $3,000,000 in gold.

Kofa district.—A small quantity of siliceous gold ore was produced from the Independence property and treated in an arrastre. Placer bullion containing $709 in gold and 8 ounces of silver was reported.

Palomas district.—Placer bullion containing $294 in gold and 2 ounces of silver was reported by operators in the district.

Planet district.—Copper sulphide ore and a small quantity of gold ore yielding bullion was produced from three properties in 1914. Shipments of dump ore from the New Planet claims represented the largest part of the production. The total output aggregated 404 tons.

[1] Min. and Sci. Press, Mar. 13, 1915, p. 419.

Plomosa district.—The output of ore and bullion from eight deep mines and six placers amounted to $9,252. Ore of shipping grade amounted to 170 tons, and contained 177.52 ounces of gold, 2,958 ounces of silver, 9,761 pounds of copper, and 12,891 pounds of lead. The principal producer of copper ore was the Shamrock property, and small shipments of gold ore were made from the Dutchman and the Old Maid claims. Placer bullion containing $2,054 in gold and 13 ounces of silver was reported by producers in the district. The larger part of this came from the Iron Queen, Copper Chief, and Middle Camp properties.

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IRON ORE, PIG IRON, AND STEEL.

By Ernest F. Burchard.

INTRODUCTION.

Although the output of iron ore, pig iron, and steel in 1914 was close to the production of 1911, the fact that 1913 was a year of record production makes the decrease for 1914 appear relatively greater than otherwise. In common with practically all the other branches of the mineral industry the iron industry suffered from the general business depression of 1914, but in particular the iron industry probably felt the depression more severely than most of the others on account of its magnitude and of the necessity for maintaining operations almost up to full capacity in order to make even small profits. As recorded in the report on iron ore for 1913, stocks of finished products were reasonably low at the end of 1913, but that year closed with general abatement of production and with low prices, so that the year 1914 began with activity at a very low ebb. During the first quarter developments gave some promise for the hope that 1914 might be a prosperous year, but the second quarter passed without material encouragement, so that when the European war began, at the close of July, its effect on the financial situation was such as still further to discourage the buying of iron and steel products and to depress prices. These conditions continued until the last part of the year and are graphically shown in the curves of monthly production and of prices of pig iron in figures 6 and 7, on page 530 of this chapter.

One feature of the iron and steel industry in 1914 that should not be overlooked in any summary of conditions is the fact that many companies, particularly in the South, kept their mines and furnaces in operation to an extent sufficient to support a large proportion of the army of persons dependent on the labor afforded in normal times, even though to have closed down might have resulted in considerable savings to the companies themselves.

As this chapter chronicles the production of iron ore for the thirty-fifth year for which the Survey has compiled the statistics, a slightly more extended review has been introduced and the historical table has been amplified. Statistics are introduced, for the first time, of beneficiated iron ore, with an outline of the processes employed in several States. Recent Survey investigations of iron ore are outlined, and digests are given of the reports of field studies in northwestern Louisiana and northeastern Texas.

On January 7, 1915, the Survey estimate of the production and shipments of iron ore in 1914 was released to the press. The estimate

was based on preliminary reports from 52 of the important iron-mining companies in the principal iron-producing districts, whose combined output approximates 90 per cent of the total for the United States. The average decrease in quantities mined and shipped by these 52 companies, as shown by the preliminary reports, was 33 per cent, indicating a production of 41,440,000 long tons and shipments of 39,810,000 long tons. This preliminary estimate therefore came very close to the final figures for production (ore mined) and for shipments, which were, respectively, 41,439,761 long tons and 39,714,280 long tons.

IRON-ORE INDUSTRY IN THE UNITED STATES.

TOTAL PRODUCTION OF IRON ORE.

In review of the annual production of iron ore for the last 35 years, the period for which yearly figures are available, it is seen that, despite the great increase in production, there has been no decade, beginning with 1880, in which there has not been a drop in production in some year; and, further, that there have been only two 5-year periods, 1885–1890 and 1895–1900, in which the production of iron ore has not been checked temporarily. This is indicated graphically in the curve (fig. 5). The years, or periods, in which production of iron ore has been checked appreciably were 1884–85, 1891, 1893, 1903–4, 1908, 1911, and 1914, and these years coincided with or closely followed periods of business depression. It is significant, however, that practically every drop in production was followed by a rise that carried the production considerably above the former level—which well illustrates the dependence of the industrial world on iron products. If buying is curtailed for any appreciable period a reaction invariably occurs, due in part to the need for replacement of outworn and obsolete material, and in part to new needs. History, therefore, holds abundant hope for a satisfactory revival from the depression of 1914. The parallelism between the curves of production of iron ore, pig iron, and steel is, of course, to expected, because these commodities are affected in common by prosperity and depression. Pig iron has been called the "barometer" of business, but strictly speaking this term is a misnomer so far as production is concerned; for depression or prosperity in business is not foreshadowed by the production of pig iron. The term "thermometer" might be used with greater propriety, as the pig-iron market quickly responds to the variations in business activity.

The general parallelism between the curves of production of iron ore, pig iron, and steel has been commented on above, and inspection of the ratio of production of iron ore and pig iron discloses that the production of the ore still bears a fairly constant ratio to the production of the metal, notwithstanding the fact that the average grade of domestic iron ore has been growing leaner in late years. The diminution in the percentage of iron in domestic ore has been offset by the application of beneficiation processes and also by the importation of high-grade ores. A gradual convergence of the curves of production of pig iron and steel occurred until 1911 when the steel production slightly exceeded that of iron; since the crossing of the curves the steel curve has continued more nearly parallel to that

of iron. Although the bulk of the pig iron now manufactured is converted into steel, the fact that more steel than iron may be manufactured in certain years is due to the use of surplus stocks of pig iron, the use of large quantities of scrap iron and steel, and the manufacture of steel direct from ore.

In the following table is shown the production of various types of iron ore in the United States as far as has been recorded or estimated. The statistics from 1889 to the present were collected by the United States Geological Survey; those for 1880 were collected for the census report of that year; those for 1881 were estimated by I. L. Bell;[a] and those from 1882 to 1888, inclusive, were estimated by James M. Swank[b] from the pig iron produced. No figures can be obtained for the production of various classes or iron ores prior to 1889, except for the census year 1880. The figures for the years previous to 1880 were calculated from the pig iron produced, which included imported ore as well as domestic ore used.

Iron ore mined in the United States, 1810–1914, in long tons.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
1810–1869					49,656,000
1870[c]–1879					44,570,527
1880	2,243,993	1,918,622	2,134,276	823,471	7,120,362
1881					7,119,643
1882					[d]8,700,000
1883					[d]8,800,000
1884					[d]7,718,129
1885					[d]7,600,000
1886					[d]10,000,000
1887					[d]11,300,000
1888					[d]12,062,530
1889	9,056,288	2,523,087	2,506,415	432,251	14,518,041
1890	10,527,650	2,559,938	2,570,838	377,617	16,036,043
1891	9,327,398	2,757,564	2,317,108	189,108	14,591,178
1892	11,646,619	2,485,101	1,971,965	192,981	16,296,666
1893	8,272,637	1,849,272	1,330,886	134,834	11,587,629
1894	9,347,434	1,472,748	972,219	87,278	11,879,679
1895	12,513,995	2,102,358	1,268,222	73,039	15,957,614
1896	12,576,288	2,126,212	1,211,526	91,423	16,005,449
1897	14,413,318	1,961,954	1,059,479	83,295	17,518,046
1898	16,150,684	1,989,681	1,237,978	55,373	19,433,716
1899	20,004,399	2,869,785	1,727,430	81,559	24,683,173
1900	22,708,274	3,231,089	1,537,551	76,247	27,553,161
1901	24,006,025	3,016,715	1,813,076	51,663	28,887,479
1902	30,532,149	3,305,484	1,688,860	27,642	35,554,135
1903	30,328,654	3,080,399	1,575,422	34,833	35,019,308
1904	23,839,477	2,146,795	1,638,846	19,212	27,644,330
1905	37,567,055	2,546,662	2,390,417	21,999	42,526,133
1906	42,481,375	2,781,063	2,469,294	17,996	47,749,728
1907	46,060,486	2,957,477	2,679,067	23,589	51,720,619
1908	31,788,564	[e]2,620,390	[e]1,547,797	26,585	35,983,336
1909	46,208,640	[e]2,839,265	[e]2,229,839	16,527	51,294,271
1910	51,367,007	[e]2,993,744	[e]2,631,835	22,320	57,014,906
1911	39,626,224	2,032,094	2,202,527	15,707	43,876,552
1912	51,345,782	1,614,486	2,179,533	10,346	55,150,147
1913	57,933,251	1,682,063	2,357,274	7,849	61,980,437
1914	38,286,670	1,537,750	1,610,203	5,138	41,439,761
Total					996,548,728

[a] Bell, I. L., Principles of the manufacture of iron and steel, p. 451, 1884.
[b] U. S. Geol. Survey, Mineral Resources, 1882 to 1888.
[c] Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.
[d] Figures given are for consumption of domestic ores. Total production for 1882, 1883, and 1884 is estimated as 9,000,000, 8,400,000, and 8,200,000 tons, respectively. See U. S. Geol. Survey Mineral Resources, 1883 and 1884.
[e] Some brown ore included in magnetite.

IRON ORE MINED AND MARKETED IN 1914.

The quantity of crude iron ore mined in the United States in 1914 amounted to 41,439,761 long tons, as compared with 61,980,437 long tons mined in 1913, a decrease of 20,540,676 long tons, or 33.14

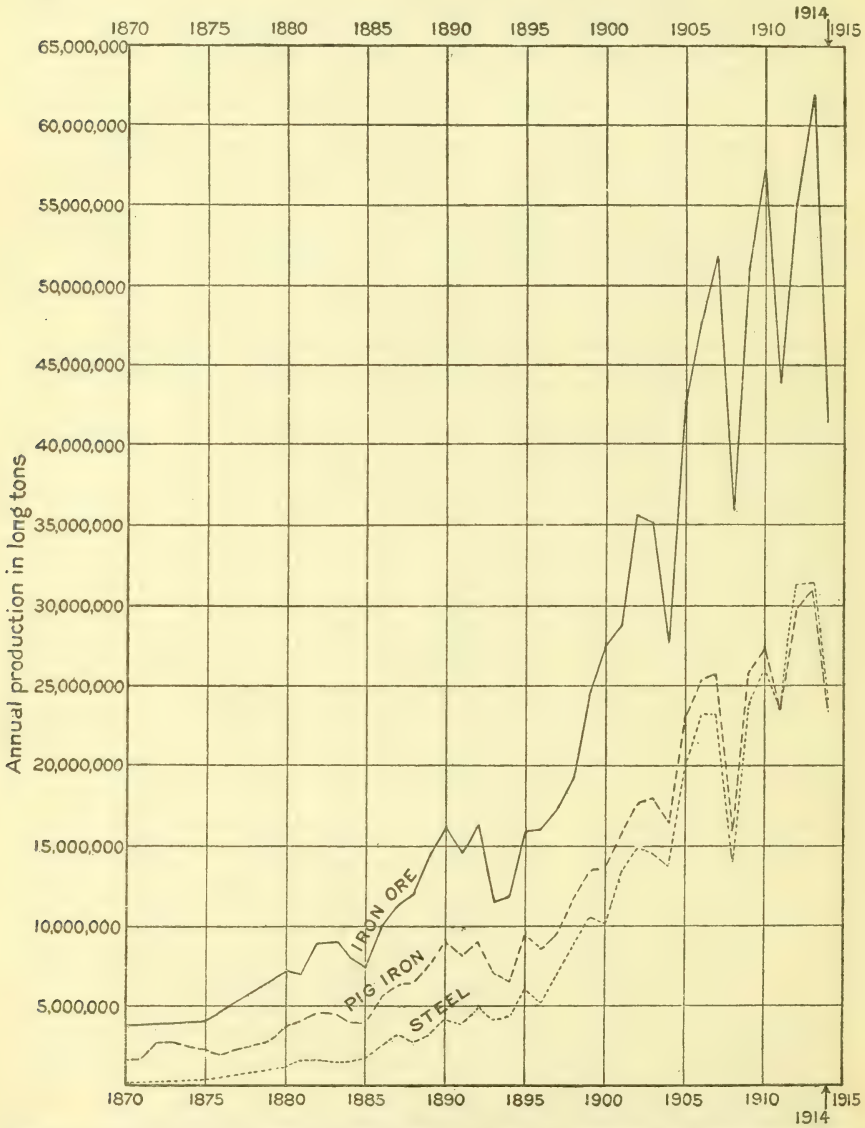

FIGURE 5.—Curve showing annual production of iron ore, pig iron, and steel in the United States, 1870–1914.

per cent. The quantity of iron ore shipped from the mines (marketed) in the United States in 1914 amounted to 39,714,280 long tons, valued at $71,905,079, as compared with 59,643,098 long tons, valued at $130,905,558, marketed in 1913. This represents a decrease in

quantity of 19,928,818 long tons, or 33.41 per cent, and in value of $59,000,479, or 45.07 per cent. The average price of ore per ton for the whole country in 1914 was $1.81, as compared with $2.19 in 1913. These quantities of ore, both mined and marketed, include the iron ore used for fluxing other metallic ores at smelters in the Western States, but the marketed ore does not include the iron ore sold for the manufacture of paint. The quantity of iron ore for paint marketed in 1914, which is reported in detail in another chapter of Mineral Resources, amounted to 18,452 long tons, valued at $46,995. The ore reported as sold for fluxing purposes other than in the manufacture of pig iron amounted to 42,677 long tons, valued at $114,985, in 1914, as compared with 62,842 long tons, valued at $235,588, in 1913. The domestic iron ore actually marketed for the manufacture of pig iron amounted in 1914, to 39,671,603 long tons, valued at $71,790,094, as compared with 59,580,256 long tons, valued at $130,669,970, in 1913.

A graphic comparison of the annual production of iron ore and its derived metals since 1870 is afforded by the curves shown in figure 5. It must be borne in mind, however, that the figures for the three products are not strictly comparable, because considerable foreign iron ore enters into the production of pig iron, and because a considerable quantity of scrap iron and steel is used in the production of new steel.

PRODUCTION OF IRON ORE BY GEOGRAPHIC DIVISIONS.

The States in which iron ore occurs may be conveniently grouped into six geographic divisions, namely:

1. *Northeastern States.*—Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Ohio.
2. *Southeastern States.*—Maryland, the Virginias, Kentucky, Tennessee, North Carolina, Georgia, and Alabama.
3. *Lake Superior States.*—Michigan, Wisconsin, and Minnesota.
4. *Mississippi Valley States.*—Iowa, Mississippi, Missouri, Arkansas, and Texas.
5. *Rocky Mountain States.*—Idaho, Montana, Wyoming, Colorado, New Mexico, Utah, and Nevada.
6. *Pacific slope States.*—Washington and California.

Each of these divisions may be subdivided into mining districts and the ores classified with regard to variety and to distribution of deposits. These subdivisions are discussed in another section. The Lake Superior is by far the most important of these divisions, and is followed in order by the southeastern division and the northeastern division; the Mississippi Valley and the western divisions are of minor importance. The table following shows the relative output of iron ore in each of these geographic divisions during 1912, 1913, and 1914.

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Iron ore mined in the United States, by geographic divisions, in 1912, 1913, and 1914, in long tons.

Division.	1912		1913		1914	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Northeastern	2,139,058	3.88	2,316,041	3.74	1,563,725	3.78
Southeastern	5,665,386	10.27	6,307,064	10.18	5,707,381	13.77
Lake Superior [a]	46,483,798	84.29	52,518,158	84.73	33,629,613	81.15
Mississippi Valley	46,480	.08	66,586	.11	37,904	.09
Rocky Mountain	812,917	1.48	770,496	1.24	499,856	1.21
Pacific slope	2,508	.....	2,092	.....	1,282	.....
Total	55,150,147	100.00	61,980,437	100.00	41,439,761	100.00

[a] Includes all Wisconsin mines.

QUANTITY OF IRON ORE MINED AND MARKETED, BY STATES.

Iron ore was mined in 27 States in 1914, as compared with 28 States in 1913. Of these States, four—Idaho, Montana, Nevada, and Utah—produced ores for fluxing only; part of Colorado's production was for flux and part for pig iron; the remaining States produced iron ore for blast-furnace use only, except small quantities for paint from Georgia, Michigan, New York, Pennsylvania, and Wisconsin, which are reported in the chapter on Mineral paints.

The rank of the five States producing the largest quantity of iron ore—Minnesota, Michigan, Alabama, Wisconsin, and New York—changed slightly in 1914, and there were also some changes in the relative rank of certain of the other producers.

The Minnesota iron ranges are still producing more iron ore than is produced in all the rest of the States together, having furnished 52.96 per cent of the total for the United States in 1914. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 33,540,403 long tons in 1914, or 80.94 per cent of the total production, as compared with 52,377,362 long tons, or 84.51 per cent in 1913.

Of the two following tables, the first gives a comparison of the iron ore mined and marketed by States for 1913 and 1914, showing the rank of each State and the percentage of the total mined and marketed in the several States, together with corresponding data for values of marketed product; and the second shows the quantity and value of the iron ore marketed in 1913 and 1914, by States, together with increase or decrease in tonnage and the percentage of increase or decrease in the various States.

Rank of States in mined and in marketed production of iron ore, 1913 and 1914.

1913.

MINED.

State.	Rank.	Quantity, in long tons.	Percentage of total.
Minnesota	1	38,658,793	62.37
Michigan	2	12,841,093	20.72
Alabama	3	5,215,740	8.42
New York	4	1,459,628	2.36
Wisconsin	5	1,018,272	1.64
Wyoming	6	537,111	.87
Pennsylvania	7	489,056	.79
Virginia	8	483,843	.78
Tennessee	9	370,002	.60
New Jersey	10	325,305	.53
New Mexico	11	164,085	.26
Georgia	12	155,236	.25
North Carolina	13	69,235	.11
Missouri	14	39,354	.06
Utah	15	14,690	.02
Ohio	16	7,849	.01
West Virginia	17	7,808	.01
Kentucky	18	3,400	.01
Montana	19	2,475	
California	20	2,092	
Other States [a]	.....	115,370	.19
Total	.....	61,980,437	100.00

[a] Colorado, Connecticut, Idaho, Maryland, Massachusetts, Mississippi, Nevada, and Texas.

MARKETED.

State.	Quantity.			Value.		
	Rank.	Long tons.	Percentage of total.	Rank.	Amount.	Percentage of total.
Minnesota	1	36,603,331	61.37	1	$80,789,025	61.72
Michigan	2	12,668,560	21.24	2	33,479,954	25.58
Alabama	3	5,333,218	8.94	3	6,648,569	5.08
New York	4	1,420,889	2.38	4	3,100,235	2.37
Wisconsin	5	896,243	1.50	5	2,149,397	1.64
Virginia	6	492,649	.83	6	983,279	.75
Pennsylvania	7	478,693	.80	8	589,038	.45
Tennessee	8	364,092	.61	9	493,556	.38
New Jersey	9	291,653	.49	7	980,303	.75
New Mexico	10	164,085	.28	11	148,405	.11
Georgia	11	153,336	.26	10	237,876	.18
Missouri	12	37,134	.06	12	83,628	.06
Utah	13	14,690	.03	13	44,628	.03
Ohio	14	8,299	.01	14	17,100	.01
Montana	15	2,475	1.20	15	7,425	.89
Other States [a]	.....	713,751		.....	1,153,140	
Total	.....	59,643,098	100.00	.....	130,905,558	100.00

[a] California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Nevada, North Carolina, Texas, West Virginia, and Wyoming.

Rank of States in mined and in marketed production of iron ore, 1913 and 1914—Contd.

1914.

MINED.

State.	Rank.	Quantity, in long tons.	Percentage of total.
Minnesota	1	21,946,901	52.96
Michigan	2	10,796,200	26.05
Alabama	3	4,838,959	11.68
Wisconsin	4	886,512	2.14
New York	5	785,377	1.89
Pennsylvania	6	406,326	.98
Virginia	7	378,520	.91
Wyoming	8	366,962	.89
New Jersey	9	350,135	.84
Tennessee	10	330,214	.80
New Mexico	11	81,980	.20
Georgia	12	67,722	.16
North Carolina	13	57,667	.14
Missouri	14	37,554	.09
Kentucky	15	21,400	.05
Colorado	16	10,464	.03
Connecticut	17	9,149	.02
Massachusetts	18	7,600	.02
West Virginia	19	6,530	.02
Maryland	20	6,369	.02
Ohio	21	5,138	.01
California	22	1,282	.10
Other States [a]	.....	40,800	
Total	.....	41,439,761	100.00

[a] Idaho, Mississippi, Montana, Nevada, and Utah.

MARKETED.

State.	Quantity.			Value.		
	Rank.	Long tons.	Percentage of total.	Rank.	Amount.	Percentage of total.
Minnesota	1	23,298,547	58.66	1	$40,628,771	56.50
Michigan	2	8,533,280	21.49	2	18,722,358	26.04
Alabama	3	4,514,926	11.37	3	5,727,619	7.96
New York	4	640,252	1.61	4	1,992,892	2.77
Wisconsin	5	591,595	1.49	5	1,178,610	1.64
Pennsylvania	6	400,062	1.01	9	399,639	.56
New Jersey	7	346,820	.87	6	1,076,208	1.50
Virginia	8	346,382	.87	7	719,415	1.00
Tennessee	9	330,214	.83	8	466,523	.65
Georgia	10	66,222	.17	10	119,363	.17
Missouri	11	36,304	.09	11	75,696	.10
Colorado	12	11,464	.03	12	22,846	.03
California	13	1,282		13	5,128	
Maryland	14	749	1.51	14	1,817	1.08
Other States [a]	.....	596,181		.....	768,194	
Total	.....	39,714,280	100.00	.....	71,905,079	100.00

[a] Connecticut, Idaho, Kentucky, Massachusetts, Mississippi, Montana, Nevada, New Mexico, North Carolina, Ohio, Utah, West Virginia, and Wyoming.

Quantity and value or iron ore marketed in the United States, 1913 and 1914, by States.

State.	1913		1914		Increase (+) or decrease (−) in 1914.		Percentage of increase (+) or decrease (−) in 1914.	
	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity.	Value.
Alabama	5,333,218	$6,648,569	4,514,926	$5,727,619	− 818,292	− $920,950	−15.34	−13.85
California	(a)	(a)	1,282	5,128	(a)	(a)	(a)	(a)
Colorado	(a)	(a)	11,464	22,846	(a)	(a)	(a)	(a)
Georgia	153,336	237,876	66,222	119,363	− 87,114	− 118,513	−56.81	−49.82
Maryland	(a)	(a)	749	1,817	(a)	(a)	(a)	(a)
Michigan	12,668,560	33,479,954	8,533,280	18,722,358	− 4,135,280	−14,757,596	−32.64	−44.08
Minnesota	36,603,331	80,789,025	23,298,547	40,628,771	−13,304,784	−40,160,254	−36.35	−49.71
Missouri	37,134	83,628	36,304	75,696	− 830	− 7,932	− 2.24	− 9.48
Montana	2,475	7,425	(a)	(a)	(a)	(a)	(a)	(a)
New Jersey	291,653	980,303	346,820	1,076,208	+ 55,167	+ 95,905	+18.92	+ 9.78
New Mexico	164,085	148,405	(a)	(a)	(a)	(a)	(a)	(a)
New York	1,420,889	3,100,235	640,252	1,992,892	− 780,637	− 1,107,343	−54.94	−35.72
Ohio	8,299	17,100	(a)	(a)	(a)	(a)	(a)	(a)
Pennsylvania	478,693	589,038	400,062	399,639	− 78,631	− 189,399	−16.43	−32.15
Tennessee	364,092	493,556	330,214	466,523	− 33,878	− 27,033	− 9.30	− 5.48
Utah	14,690	44,628	(a)	(a)	(a)	(a)	(a)	(a)
Virginia	492,649	983,279	346,382	719,415	− 146,267	− 263,864	−29.69	−26.84
Wisconsin	896,243	2,149,397	591,595	1,178,610	− 304,648	− 970,787	−33.99	−45.17
Other States [b]	713,751	1,153,140	596,181	768,194	− [a] 293,624	− [a] 572,713	−[a]32.51	−[a]41.78
Total	59,643,098	130,905,558	39,714,280	71,905,079	−19,928,818	−59,000,479	−33.41	−45.07

[a] Increases or decreases for California, Colorado, Maryland, Montana, New Mexico, Ohio, and Utah included with those for "Other States."

[b] 1913: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Nevada, North Carolina, Texas, West Virginia, and Wyoming; 1914: Connecticut, Idaho, Kentucky, Massachusetts, Mississippi, Montana, Nevada, New Mexico, North Carolina, Ohio, Utah, West Virginia, and Wyoming.

PRODUCTION OF IRON ORE, BY VARIETIES, BY STATES, AND BY MINING DISTRICTS.

Iron minerals are classified as sulphides, oxides, carbonates, silicates, of which only the oxides and the carbonates are used in the iron and steel industry, except a very small quantity of by-product from sulphide ores used in manufacture of sulphuric acid. The ores of iron are generally classed under four heads:

Hematite, including all varieties of the anhydrous sesquioxide (Fe_2O_3—theoretical percentage of iron, 70). This is known locally as red hematite, specular ore, gray ore, fossil ore, oolitic ore, and so on.

Brown ore, including hydrated sesquioxides, such as limonite, göthite, and turgite, or a mixture of these minerals ($Fe_2O_3nH_2O$—theoretical percentages of iron, 59.8—66.2). This is known locally as brown ore, brown hematite, bog ore, and limonite.

Magnetite, including magnetic oxides (Fe_3O_4—theoretical percentage of iron, 72.4). Magnetite is known generally as magnetic iron ore.

Iron carbonate, including carbonates of various types ($FeCO_3$—theoretical percentage of iron, 48.2). Iron carbonate is known locally as spathic iron ore, kidney ore, black-band ore, and siderite.

Hematite has always been predominant as an ore of iron and at present constitutes more than nine-tenths of the iron ore produced in the United States. Brown ore and magnetite are far below it in importance; brown ore and magnetite furnish at present less than 8 per cent of the total production of iron ore. The production of iron carbonate is insignificant in comparison with that of the other ores; in 1914 it constituted only about 0.012 per cent of the total.

In the following tables are shown the quantities of each of the classes of iron ores mined in the various States and mining districts during 1913 and 1914:

Iron ore mined in the United States in 1913 and 1914, by States and varieties, with percentage of increase or decrease in 1914, in long tons.

1913.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.
Alabama	4,370,823	844,917	.....	.....	5,215,740
California	.....	.....	2,092	.....	2,092
Georgia	59,076	96,160	.....	.....	155,236
Kentucky	3,400	.....	.....	.....	3,400
Michigan	12,841,093	.....	.....	.....	12,841,093
Minnesota	[a]38,658,793	.....	.....	.....	38,658,793
Missouri	33,709	5,645	.....	.....	39,354
Montana	.....	2,475	.....	.....	2,475
New Jersey	.....	.....	325,305	.....	325,305
New Mexico	.....	.....	164,085	.....	164,085
New York	118,776	.....	1,340,852	.....	1,459,628
North Carolina	.....	.....	69,235	.....	69,235
Ohio	.....	.....	.....	7,849	7,849
Pennsylvania	(b)	[b] 34,041	455,015	.....	489,056
Tennessee	244,156	125,256	590	.....	370,002
Utah	.....	[c] 14,690	(c)	.....	14,690
Virginia	44,642	439,201	.....	.....	483,843
West Virginia	.....	7,808	.....	.....	7,808
Wisconsin	1,018,272	.....	.....	.....	1,018,272
Wyoming	537,111	.....	.....	.....	537,111
Other States [d]	.....	115,370	.....	.....	115,370
Total	57,933,251	1,682,063	2,357,274	7,849	61,980,437

[a] Includes some brown ore and a little magnetic ore.
[b] Hematite included in brown ore.
[c] Magnetite included in brown ore.
[d] Colorado, Connecticut, Idaho, Maryland, Massachusetts, Mississippi, Nevada, and Texas.

1914.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.	Percentage of increase (+) or decrease (−) in 1914.
Alabama	3,902,567	936,392	.....	.....	4,838,959	− 7.22
California	.....	.....	1,282	.....	1,282	− 38.72
Colorado	.....	10,464	.....	.....	10,464	(a)
Connecticut	.....	9,149	.....	.....	9,149	(a)
Georgia	11,836	55,886	.....	.....	67,722	− 56.37
Kentucky	21,400	.....	.....	.....	21,400	+529.41
Maryland	.....	6,369	.....	.....	6,369	(a)
Massachusetts	.....	7,600	.....	.....	7,600	(a)
Michigan	10,796,200	.....	.....	.....	10,796,200	− 15.92
Minnesota	21,946,901	.....	.....	.....	21,946,901	− 43.23
Missouri	32,054	5,500	.....	.....	37,554	− 4.57
New Jersey	.....	.....	350,135	.....	350,135	+ 7.63
New Mexico	.....	.....	81,980	.....	81,980	− 50.04
New York	49,704	.....	735,673	.....	785,377	− 46.19
North Carolina	.....	.....	57,667	.....	57,667	− 16.71
Ohio	.....	.....	.....	5,138	5,138	− 34.54
Pennsylvania	3,300	23,560	379,466	.....	406,326	− 16.92
Tennessee	202,330	123,884	4,000	.....	330,214	− 10.75
Virginia	66,904	311,616	.....	.....	378,520	− 21.77
West Virginia	.....	6,530	.....	.....	6,530	− 16.37
Wisconsin	886,512	.....	.....	.....	886,512	− 12.94
Wyoming	366,962	.....	.....	.....	366,962	− 31.68
Other States [b]	.....	40,800	.....	.....	40,800	− 43.88
Total	38,286,670	1,537,750	1,610,203	5,138	41,439,761	− 33.14

[a] Less than three producers in Colorado, Connecticut, Maryland, and Massachusetts in 1913 and in Montana and Utah in 1914, and permission was not granted to publish State totals. Increases and decreases in 1914, therefore, included in "Other States."
[b] Idaho, Mississippi, Montana, Nevada, and Utah.

Iron ore mined in the United States, by mining districts and varieties, in 1913 and 1914, with percentage of increase or decrease in 1914, in long tons.

1913.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
Lake Superior [a]	52,377,362	.....	.....	.....	52,377,362
Birmingham	4,159,837	442,736	.....	.....	4,602,573
Chattanooga	491,770	216,849	.....	.....	708,619
Adirondack	.....	.....	1,214,704	.....	1,214,704
Northern New Jersey and southeastern New York	.....	.....	451,453	.....	451,453
Other districts	904,282	1,022,478	691,117	7,849	2,625,726
Total	57,933,251	1,682,063	2,357,274	7,849	61,980,437

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district, and includes some brown ore and a little magnetic ore.

1914.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.	Percentage of increase (+) or decrease (—) in 1914.
Lake Superior [a]	33,540,403	.....	.....	.....	33,540,403	−35.96
Birmingham	3,813,447	469,109	.....	.....	4,282,556	− 6.95
Chattanooga	280,146	151,860	.....	.....	432,006	−39.04
Adirondack	.....	.....	544,724	.....	544,724	−55.16
Northern New Jersey and southeastern New York	.....	.....	541,084	.....	541,084	+19.85
Other districts	652,674	916,781	524,395	5,138	2,098,988	−20.06
Total	38,286,670	1,537,750	1,610,203	5,138	41,439,761	−33.14

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district, and includes some brown ore and a little magnetic ore.

These tables show that the great bulk of the hematite comes from the Lake Superior district (Michigan, Minnesota, and Wisconsin) and Alabama, the bulk of the brown ore from the Appalachian States, and the magnetite from New York, New Jersey, and Pennsylvania. The iron carbonate is produced in Ohio, but Mississippi produced in 1913 a little carbonate ore, so intimately mixed with brown ore that the whole output is tabulated as brown ore. On a later page is given the production of the principal ranges in the Lake Superior district. It is a well-known fact that the great bulk of the Lake Superior hematite is more or less hydrated, and that many deposits include masses of brown ore having varying percentages of combined water. There is, however, a complete gradation from anhydrous hematite to limonite, and as there is no sharp dividing line and as also the greater part of the ore is nearer the anhydrous than the completely hydrated condition, the production of the hydrated ores is included in the production of hematite. The ores mined in the Crystal Falls and Iron River areas of the Menominee Range are, on the whole, considered to be somewhat more hydrated than other ores of the Lake Superior district. According to the analyses of Lake Superior iron ores given in Geological Survey Monograph 52, pages 477–479, the average loss by ignition, which includes the combined water of the ore, was 4.12 per cent in 1909 and the range in percentage was between 0.40 and 11.40. As the combined water in a true limonite is 14.4 per cent, it is seen that the ores

as a whole fall well below the limonite content of water. Certain mines in northern Michigan produce an ore which is locally termed magnetite, but which is a coarsely crystalline anhydrous ore consisting dominantly of hematite, but having sufficient quantities of magnetite distributed through it to render the ore strongly magnetic. This magnetic ore is also included with hematite in the tables of production, both because it is not a true magnetite and because the quantity is not of sufficient importance to warrant making additional tables for magnetic ores.

The output of the magnetite mines in northern New Jersey and southeastern New York showed an increase of nearly 20 per cent in 1914; the quantity of iron ore mined in the other districts showed decreases varying from about 7 per cent to 55 per cent.

PRINCIPAL IRON-ORE MINES.

In 1914 there were 340 iron-ore mines active, as compared with 411 mines in 1913, and 164 mines produced more than 50,000 long tons of iron ore each, as compared with 194 mines in 1913. Of these 164 mines 5 produced more than 1,000,000 tons each in 1914, as compared with 12 in 1913. The Red Mountain group of red hematite mines in the Birmingham district, Ala., led in 1914 with an output of 2,008,465 long tons of ore, although this quantity is nearly 200,000 tons lower than the output of this group in 1913. The Hull-Rust mine, on the Mesabi range near Hibbing, Minn., held the record in 1913 with an output of 3,457,608 long tons of hematite, but the output of this mine was curtailed greatly in 1914, so that it ranked nineteenth, with an output of 458,468 long tons. Four of the five mines producing more than 1,000,000 tons in 1914 are in Minnesota.

The largest producer in Michigan in 1914 was the Norrie group, which reported having mined 991,291 long tons of hematite. Permission has been granted to the Survey by the owners and operators of 144 of these large mines to publish their production, and these statistics are given in the following table:

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1914

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Long tons.
1	Red Mountain group	Alabama	Bessemer	Hematite	2,008,465
2	Mahoning	Minnesota	Hibbing	do	1,212,287
3	Sauntry-Alpena	do	Virginia	do	1,156,150
4	Canisteo	do	Coleraine	do	1,051,895
5	Leonard	do	Chisholm	do	1,022,490
6	Norrie group	Michigan	Ironwood	do	991,291
7	Newport	do	do	do	950,243
8	Uno	Minnesota	Hibbing	do	947,502
9	Susquehanna	do	do	do	906,913
10	Woodward 1, 2, and 3	Alabama	Lipscomb	do	650,507
11	Shenango	Minnesota	Chisholm	do	619,569
12	Leetonia	do	Hibbing	do	592,940
13	Hill	do	Marble	do	592,685
14	Fayal	do	Eveleth	do	568,480
15	Spruce	do	do	do	561,136
16	Zenith	do	Ely	do	530,215
17	Genoa	do	Gilbert	do	510,624
18	Holman	do	Taconite	do	486,630
19	Hull-Rust	do	Hibbing	do	458,468
20	Chisholm	do	Chisholm	do	398,091
21	Clark	do	do	do	381,552
22	Cornwall	Pennsylvania	Miners Village	Magnetite	376,929

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1914—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Long tons.
23	Commodore	Minnesota	Virginia	Hematite	372,796
24	Montreal	Wisconsin	Hurley	do	367,600
25	Dale	Minnesota	Hibbing	do	349,177
26	Kinney	do	Kinney	do	347,376
27	Caspian	Michigan	Palatka	do	347,042
28	Sunrise	Wyoming	Sunrise	do	331,192
29	Pioneer	Minnesota	Ely	do	328,897
30	Witherbee, Sherman & Co. (Inc.).	New York	Mineville	Magnetite	328,075
31	Chapin	Michigan	Iron Mountain	Hematite	321,841
32	Penn	do	Norway and Vulcan.	do	319,328
33	Norman	Minnesota	Virginia	do	318,628
34	Wakefield	Michigan	Wakefield	do	315,192
35	Pewabic	do	Iron Mountain	do	281,745
36	Colby	do	Bessemer	do	278,747
37	Adams	Minnesota	Eveleth	do	277,225
38	Miller	do	Aurora	do	259,776
39	Leonidas	do	Eveleth	do	259,588
40	Biwabik	do	Biwabik	do	254,060
41	Burt	do	Hibbing	do	250,747
42	Utica	do	do	do	248,417
43	Union	do	Virginia	do	244,268
44	Armour No. 2	do	Crosby	do	238,427
45	Bristol	Michigan	Crystal Falls	do	234,445
46	Lincoln	Minnesota	Virginia	do	232,289
47	Hawkins	do	Nashwauk	do	231,970
48	Queen group	Michigan	Negaunee	do	231,936
49	Raimund No. 1	Alabama	Bessemer	do	231,363
50	Graham	Minnesota	Mesaba	do	230,106
51	Albany	do	Hibbing	do	227,766
52	Aurora	Michigan	Ironwood	do	220,241
53	Palms	do	Bessemer	do	215,351
54	Riverton group	do	Iron River	do	213,414
55	Aragon	do	Norway	do	196,565
56	Sliver	Minnesota	Virginia	do	196,352
57	Kennedy	do	Cuyuna	do	196,225
58	Bangor	do	Biwabik	do	194,716
59	Thompson	do	Crosby	do	178,354
60	Elba	do	Gilbert	do	177,647
61	Rolling Mill	Michigan	Negaunee	do	169,275
62	Harold	Minnesota	Hibbing	do	167,959
63	Ottawa	Wisconsin	Hurley	do	167,830
64	Lake Superior	Michigan	Ishpeming	do	165,853
65	Monroe-Tener	Minnesota	Chisholm	do	162,509
66	Cary	Wisconsin	Hurley	do	158,646
67	Belgrade	Minnesota	Biwabik	do	158,606
68	Secton 30	do	Ely	do	155,562
69	Zimmerman	Michigan	Stambaugh	do	152,000
70	Songo	Alabama	Songo	do	150,732
71	Helmer	Minnesota	Kinney	do	150,000
72	Pettit	do	Gilbert	do	147,704
73	Laura	do	Hibbing	do	146,689
74	Mace	do	do	do	144,308
75	Steinman	Alabama	Steinman	do	144,195
76	Brown Mining Co	Tennessee	Cardiff	do	141,745
77	Adriatic	Minnesota	Mesaba	do	137,371
78	Greeley	Alabama	Greeley	Brown ore	136,289
79	Cambria	Michigan	Negaunee	Hematite	131,730
80	Ravenna	do	Crystal Falls	do	130,531
81	Sunday Lake	do	Wakefield	do	129,757
82	Richmond	do	Palmer	do	129,551
83	Davidson No. 1	do	Iron River	do	129,321
84	Hudson	Minnesota	Aurora	do	127,526
85	Minorca	do	Virginia	do	126,587
86	Stevenson	do	Hibbing	do	126,140
87	Lake Angeline	Michigan	Ishpeming	do	122,959
88	Sibley	Minnesota	Ely	do	122,886
89	Chicagon	Michigan	Iron River	do	119,684
90	Tilden	do	Bessemer	do	118,073
91	Washington	New Jersey	Oxford	Magnetite	115,878
92	Mississippi	Minnesota	Keewatin	Hematite	114,552
93	Ashland	Michigan	Ironwood	do	112,362
94	Grant	Minnesota	Buhl	do	111,442
95	Asteroid	Michigan	Ramsay	do	111,432
96	American-Boston	do	Diorite	do	111,256
97	Hiawatha	do	Iron River	do	110,716
98	Loretto	do	Loretto	do	108,682

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1914—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Long tons.
99	Agnew	Minnesota	Hibbing	Hematite	108,568
100	Grace	do	do	do	98,385
101	Forbes	Michigan	Iron River	do	97,710
102	Judd	Minnesota	Taconite	do	95,416
103	Osana	Michigan	Iron River	do	90,630
104	Carpenter	do	Crystal Falls	do	90,585
105	Port Henry, No. 21	New York	Mineville	Magnetite	87,748
106	Mayville	Wisconsin	Mayville	Hematite	86,994
107	Corsica	Minnesota	Gilbert	do	85,687
108	Hanna B	do	Mountain Iron	do	83,939
109	Monica	do	Biwabik	do	83,602
110	Yale	Michigan	Bessemer	do	83,289
111	Mount Hope	New Jersey	Mount Hope	Magnetite	82,909
112	Snow Flake	Mew Mexico	Fierro	do	81,980
113	Friedman	Alabama	Woodstock	Brown ore	81,556
114	Davidson, No. 2	Michigan	Iron River	Hematite	80,649
115	Mohawk	Minnesota	Aurora	do	79,750
116	Puritan	Michigan	Ironwood	do	79,171
117	Raimund, No. 2	Alabama	Bessemer	do	77,823
118	Myers	Minnesota	Chisholm	do	75,776
119	Ironaton	Alabama	Ironaton	Brown ore	75,245
120	Bennett	Minnesota	Keewatin	Hematite	74,314
121	Knox	do	Mesaba	do	73,234
122	Houston	Alabama	Rickey	Brown ore	70,720
123	Cavour	Minnesota	Virginia	Hematite	69,175
124	Mary Charlotte, Nos. 1 and 2	Michigan	Negaunee	do	69,064
125	Brotherton	do	Wakefield	do	68,808
126	Docray	Alabama	Docray	Brown ore	67,237
127	Meadow	Minnesota	Aurora	Hematite	66,590
128	Tully	Michigan	Stambaugh	do	66,428
129	Clifford (or Traders)	do	Iron Mountain	do	66,329
130	Castile	do	Wakefield	do	65,914
131	Soudan	Minnesota	Soudan	do	65,825
132	Savoy	do	Ely	do	65,031
133	Chandler	do	do	do	63,000
134	Attalla	Alabama	Attalla	do	60,153
135	Oriskany	Virginia	Oriskany	Brown ore	58,008
136	Eureka	Michigan	Ramsay	Hematite	57,815
137	Cranberry	North Carolina	Cranberry	Magnetite	57,667
138	Baker	Michigan	Stambaugh	Hematite	57,459
139	Tannehill	Alabama	Goethite	Brown ore	56,729
140	Buckeye	Wisconsin	Commonwealth	Hematite	54,735
141	Woodbridge	Minnesota	Buhl	do	53,785
142	Franklin	do	Virginia	do	53,509
143	Breitung Hematite, No. 1	Michigan	Negaunee	do	52,074
144	Adams	do	Ishpeming	do	50,482
	Total (144 mines)				35,563,778
	Unspecified (20 mines) [a]				3,394,704
	Tonnage from mines producing more than 50,000 long tons each				38,958,482
	Tonnage from mines producing less than 50,000 long tons each				2,481,279
	Grand total of United States				41,439,761

[a] Includes the product of 20 mines producing over 50,000 long tons each, operated by 10 companies, which do not permit the publication of individual figures.

STOCK OF IRON ORE AT MINES.

According to the reports of producers, a few of which have been revised since the report for 1913 was published, the total quantity of iron ore in stock at the mines at the close of 1914 amounted to 14,361,625 long tons, compared with 12,757,616 tons at the close of 1913, an increase of 1,604,009 tons, or 12.57 per cent, which balances fairly well with the excess of ore mined over quantity shipped or used. As the tonnage of ore in stock piles is necessarily partly estimated,

there are variations in the mine reports from year to year which prevent an absolute balance between the quantity mined and the quantity sold and stocks on hand. Certain stocks of ore in Mississippi, Texas, and West Virginia, which were included in the total for 1913, have been ascertained to be noncommercial and consequently have been dropped in compiling the figures for 1914.

The following table gives the reported stocks of iron ore at the mines December 31, 1913 and 1914, by States:

Stock of iron ore at mines Dec. 31, 1913 and 1914, by States, in long tons.

State.	1913	1914
Alabama	255,722	580,171
Colorado	1,000	.....
Connecticut	265	.....
Georgia	1,800	2,200
Maryland	3,200	5,050
Massachusetts	3,400	5,500
Michigan	4,590,977	6,797,280
Minnesota	7,273,111	5,876,180
Missouri	4,190	5,720
New Jersey	157,542	158,543
New York	82,854	215,503
Ohio	3,894	3,435
Pennsylvania	36,551	43,037
Tennessee	15,144	15,144
Utah	130	130
Virginia	52,824	85,533
Wisconsin	275,012	568,199
Total	12,757,616	14,361,625
Percentage of increase in 1914	.....	12.57

PRICES OF IRON ORE PER TON.

In the following table the price per ton of the different classes of iron ore in 1913 and 1914 is given for each of the producing States or groups of States, except where there were less than three producers of a certain variety of ore and permission was not given to publish in a State whose total may be published as in Missouri, Pennsylvania, and Tennessee. The total average prices per long ton (the whole United States considered) in 1914 were: Hematite, $1.79; brown ore, $1.72; magnetite, $2.39; carbonate, $2.44, as compared with prices, respectively, of $2.21, $1.88, $2.07, and $2.06 in 1913. These figures represent the price at the mines and are taken directly from statements of the producers. They are probably only approximately correct. The element of inaccuracy is due to the fact that by far the greater bulk of the iron ore produced in the United States is mined by iron and steel producers for their own furnaces, and the value placed on such ore is therefore largely a matter of accounting. Some of the reports made to the Survey evidently include merely actual mining costs; others contain, in addition, the cost of selling and insuring the ore; in others an allowance for sinking fund is included; and in still others the figures given are prices used in charging costs against the blast furnaces. At any rate, they include no freight costs.

The general average price per long ton of all kinds of iron ore in the United States was $1.81 in 1914, compared with $2.19 in 1913, a decrease of 38 cents a ton, or 17.4 per cent. It is of interest to compare the prices given below with those of previous years and of the Lake Superior ores at the lower Lake ports given in subsequent tables.

Average price per long ton of iron ore marketed in the United States in 1913 and 1914, by States and varieties.

State.	Hematite.		Brown ore.		Magnetite.		Carbonate.	
	1913	1914	1913	1914	1913	1914	1913	1914
Alabama	$1.18	$1.21	$1.61	$1.49				
California					(a)	$4.00		
Colorado			(a)	1.99				
Georgia	1.34	1.70	1.68	1.82				
Maryland			(a)	2.43				
Michigan	2.64	2.19						
Minnesota	2.21	1.74						
Missouri	2.28	2.10	2.00	(a)				
Montana			3.00	(a)				
New Jersey					$3.36	3.10		
New Mexico			.90	(a)				
New York	1.94	2.10			2.20	3.17		
Ohio							$2.06	$2.44
Pennsylvania	(a)	(a)	2.70	2.89	(a)	(a)		
Tennessee	1.27	1.23	1.52	1.69	(a)	(a)		
Virginia	1.68	1.74	2.02	2.16				
Wisconsin	2.40	1.99						
Other States [b]	1.04	1.01	3.60	2.83	3.03	1.31		
Total average	2.21	1.79	1.88	1.72	2.07	2.39	2.06	2.44

[a] Less than three producers and permission to publish not given; therefore, price may not be shown.
[b] 1913: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Nevada, North Carolina, Texas, Utah, West Virginia, and Wyoming; 1914: Connecticut, Idaho, Kentucky, Massachusetts, Mississippi, Montana, Nevada, New Mexico, North Carolina, Utah, West Virginia, and Wyoming.

The next table gives the general average price per ton of all iron ores produced in the United States in 1889 and since 1892, and also the average price by varieties of ore since 1906:

Average price per long ton of iron ore in the United States, 1889 and 1892 to 1914, by varieties.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	General average.
1889					$2.30
1892					2.04
1893					1.66
1894					1.14
1895					1.14
1896					1.42
1897					1.08
1898					1.14
1899					1.42
1900					2.42
1901					1.71
1902					1.84
1903					1.89
1904					1.56
1905					1.77
1906	$2.13	$1.78	$2.05	$1.75	2.11
1907	2.63	1.81	2.03	1.74	2.55
1908	2.32	1.70	2.40	1.38	2.27
1909	2.17	1.68	2.40	1.73	2.15
1910	2.52	1.76	2.36	1.61	2.47
1911	2.12	1.72	2.29	1.83	2.11
1912	1.87	1.79	2.18	1.96	1.88
1913	2.21	1.88	2.07	2.06	2.19
1914	1.79	1.72	2.39	2.44	1.81

APPARENT CONSUMPTION OF IRON ORE COMPARED WITH PRODUCTION OF PIG IRON.

The following table includes data on certain items from which an approximate estimate of the annual consumption of iron ore in the United States is deduced. The result is, of course, merely an approximation, for no data are available on certain items, such as stocks at furnaces, which should enter into the final result. The items considered in the table and estimates for all years preceding 1911 are (1) domestic production of iron ore; (2) stocks of ore at mines for current year and past year; (3) stocks of ore at lower Lake ports for current year and past year; (4) production of zinc residuum; (5) imports of ore; (6) exports of ore. Beginning with 1911 data on the shipments of ore became available, and these figures together with zinc residuum and imports of ore, constitute the available supply, which, less the exports, gives the apparent consumption, without consideration of the stocks at mines and at Lake ports. Of course this apparent consumption includes some ore not used in the manufacture of pig iron, such as ore consumed in the open-hearth process and in smelting gold, silver, and copper; but it does not include ore used in the manufacture of paint. It may be possible for the Survey to present in the report for 1915 the statistics of domestic ore consumed in the manufacture of pig iron. Heretofore such figures have not been sufficiently complete for publication.

In the same table is included the production of pig iron, including ferromanganese, spiegeleisen, ferrosilicon, and other ferroalloys, for corresponding years and the percentage ratio of pig iron produced to iron ore consumed. On later pages of the report will be found detailed data on the production and shipments of pig iron.

The percentage ratio of pig iron manufactured to iron ore consumed was 57.45 per cent in 1914, as compared with 50.52 per cent in 1913. This ratio in 1914 is the highest percentage shown for the last 26 years, except that for 1893, which was 61.33 per cent. The tendency in iron-ore mining to produce higher-grade ore in times of small demand than in prosperous times, when the maximum output is demanded, is clearly shown in the last column of the following table. In the years 1893, 1904, 1908, 1911, and 1914 there were notable decreases in production of iron ore and in each of these years except 1908 the percentage ratio of pig iron produced to iron ore consumed rose between 2 and 7 per cent.

Apparent consumption of iron ore compared with production of pig iron in the United States, 1889–1914, in long tons.

Year.	Domestic iron ore produced.[a]	Stocks of ore at mines.	Stocks of ore at lower Lake ports Dec. 1.	Zinc residuum.	Imports.	Exports.	Apparent consumption.	Pig iron produced.[b]	Percentage ratio of pig iron to iron ore.
1889	14,518,041	2,256,973	2,607,106	43,648	853,573	.....	14,366,562	7,603,642	52.93
1890	16,036,043	2,000,000	3,893,487	48,560	1,246,830	.....	16,302,025	9,202,703	56.45
1891	14,591,178	2,450,279	3,508,489	38,228	912,864	.....	15,476,989	8,279,870	53.50
1892	16,296,666	2,911,740	4,149,451	31,859	806,585	.....	16,032,687	9,157,000	57.11
1893	11,587,629	3,526,161	4,070,710	37,512	526,951	.....	11,616,412	7,124,502	61.33
1894	11,879,679	3,236,198	4,834,247	26,981	167,307	.....	11,600,393	6,657,388	57.39
1895	15,957,614	2,976,494	4,415,712	43,249	524,153	.....	17,203,255	9,446,308	54.91
1896	16,005,449	3,405,302	4,954,984	44,953	682,806	.....	15,765,128	8,623,127	54.70
1897	17,518,046	3,098,287	5,923,755	33,924	489,970	.....	17,380,184	9,652,680	55.54
1898	19,433,716	2,846,457	5,136,407	48,502	187,208	.....	20,708,604	11,773,934	56.86
1899	24,683,173	2,320,278	5,530,283	65,010	674,082	40,665	25,513,903	13,620,703	53.39
1900	27,553,161	3,709,950	5,904,670	87,110	897,831	51,460	26,722,583	13,789,242	51.60
1901	28,887,479	4,239,823	5,859,663	52,311	966,950	64,703	29,357,171	15,878,354	54.09
1902	35,554,135	3,834 717	7,074,254	65,246	1,165,470	88,445	35,886,921	17,821,307	49.66
1903	35,019,308	6,297,888	6,371,085	73,264	980,440	80,611	34,232,399	18,009,252	52.61
1904	27,644,330	4,666,931	5,763,399	68,189	487,613	213,865	30,224,910	16,497,033	54.58
1905	42,526,133	3,812,281	6,438,967	90,289	845,651	208,017	43,433,138	22,992,380	52.94
1906	47,749,728	3,281,789	6,252,455	93,461	1,060,390	265,240	49,355,343	25,307,191	51.28
1907	51,720,619	3,033,110	7,385,728	93,413	1,229,168	278,608	51,879,998	25,781,361	49.69
1908	35,983,336	6,065,397	8,441,533	110,225	776,898	309,099	32,473,268	15,936,018	49.74
1909	51,294,271	6,135,271	8,965,789	141,264	1,694,957	455,934	52,080,428	25,795,471	49.53
1910	57,014,906	9,422,285	9,426,881	137,173	2,591,031	748,875	55,246,129	27,303,567	49.42
1911	41,092,447	.....	.....	109,296	1,811,732	768,386	42,245,089	23,649,547	55.98
1912	57,017,614	.....	.....	104,670	2,104,576	1,195,742	58,031,118	29,726,937	51.23
1913	59,643,098	.....	.....	102,239	2,594,770	1,042,151	61,297,956	30,966,152	50.52
1914	39,714,280	.....	.....	100,198	1,350,588	551,618	40,613,448	23,332,244	57.45

[a] Beginning with 1910, iron ore sold for paint excluded from production and included in metallic paint. Beginning with 1911, figures represent shipments.
[b] From annual reports of the American Iron and Steel Association prior to 1912, and including ferroalloys produced in blast furnaces; beginning with 1912, according to American Iron and Steel Institute, and also including ferroalloys.

IRON-ORE INDUSTRY IN THE LAKE SUPERIOR DISTRICT.

PRODUCTION OF IRON ORE IN THE LAKE SUPERIOR DISTRICT, BY RANGES.

The Lake Superior district includes the Vermilion, Mesabi, Cuyuna, Gogebic, Marquette, and Menominee ranges, in the States of Minnesota, Michigan, and Wisconsin. The Menominee range includes the Crystal Falls, Metropolitan, Iron River, and Florence areas; the Marquette range includes the Republic and Swanzy areas. The Baraboo and Iron Ridge areas of southern Wisconsin and the Spring Valley area of northwestern Wisconsin have been also included in the Lake Superior district. In the first group of ranges the ore mined is almost entirely Algonkian hematite, belonging to the Huronian series. The Baraboo ore is of the same nature, but the Iron Ridge ore is "Clinton" hematite, and the Spring Valley ore is brown ore. No ore is produced in the Baraboo area, developments having been abandoned on account of unsatisfactory quality of ore and too great quantity of underground water.

In addition to these ranges, there are several iron-ore districts on the Canadian side of the Great Lakes, the principal ones of which are the Michipicoten, Animikie, Matawin, and Atikokan. The production of these districts is, of course, not included in these statistics.

The ranges in the United States which produced ore in 1914 were the Vermilion, Mesabi, Gogebic, Marquette, Menominee, and Cuyuna, besides the Iron Ridge area. Much development work was done on the Cuyuna range, which made its first shipments in 1911.

The total quantity of ore mined from the Lake Superior district district, excluding the Iron Ridge area, in 1914 was 33,540,403 long tons, compared with 52,377,362 long tons in 1913, a decrease of 18,836,959 tons, or 35.96 per cent. An analysis of reported quantity mined in 1914, by ranges, in the Lake Superior district shows that the Mesabi range mined 19,808,434 tons of iron ore, compared with 36,378,671 tons in 1913, a decrease of 45.55 per cent; the Menominee range 3,671,499 tons, compared with 4,997,246 tons in 1913, a decrease of 26.53 per cent; the Gogebic range 4,601,240 tons, compared with 4,743,515 tons in 1913, a decrease of 3 per cent; the Marquette range, 3,320,763 tons, compared with 3,977,808 tons in 1913, a decrease of 16.52 per cent; the Vermilion range 1,362,416 tons, compared with 1,536,115 tons in 1913, a decrease of 11.31 per cent; and the Cuyuna range, which in 1914 entered upon its fourth year as a shipper of ore, 776,051 tons, compared with 744,007 tons in 1913, an increase of 4.31 per cent. The Cuyuna was thus the only range to show an increased production in 1914.

The Mesabi range produced 59.06 per cent of the entire Lake Superior output and nearly 48 per cent of the entire production of the United States. The Gogebic, Menominee, and Marquette ranges are next in importance, the Gogebic producing in 1914 about 238,000 tons less than the State of Alabama, which is the next State in importance as a producer after Minnesota and Michigan. The Vermilion range, the fifth in importance of the six producing Lake Superior ranges, produced nearly 54 per cent more ore in 1914 than Wisconsin, which is fourth in importance as an iron-ore producing State.

The following table shows the production of the first six of these ranges for 1913 and 1914, as they constitute the Lake Superior district proper:

Production of iron ore (quantity mined) in the Lake Superior region,[a] 1913–14, by ranges, in long tons.

Range.	1913	1914	Increase (+) or decrease (−) in 1914.	Percentage of increase (+) or decrease (−) in 1914.	Percentage of total production in Lake Superior region, 1914.
Marquette (Michigan)	3,977,808	3,320,763	− 657,045	−16.52	9.90
Menominee (Michigan and Wisconsin)	4,997,246	3,671,499	−1,325,747	−26.53	10.95
Gogebic (Michigan and Wisconsin)	4,743,515	4,601,240	− 142,275	− 3.00	13.72
Vermilion (Minnesota)	1,536,115	1,362,416	− 173,699	−11.31	4.06
Mesabi (Minnesota)	36,378,671	19,808,434	−16,570,237	−45.55	59.06
Cuyuna (Minnesota)	744,007	776,051	+ 32,044	+ 4.31	2.31
Total	52,377,362	33,540,403	−18,836,959	−35.96	100.00

[a] Includes only such Wisconsin mines as are in the true Lake Superior district.

In the following table is shown the total production of the Lake Superior district by ranges. The figures prior to 1872 were collected by A. P. Swineford, editor Marquette Mining Journal;[1] those for 1872 to 1877, inclusive, are from the Michigan Mineral Statistics; those from 1878 to 1888, inclusive, were collected by W. J. Stevens;[2] and the later figures were collected by the United States Geological Survey.

Production of Lake Superior iron ore, 1854–1914, by ranges, in long tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Cuyuna.	Total.
1854–1869	3,112,209						3,112,209
1870	859,507						859,507
1871	813,984						813,984
1872	948,553						948,553
1873	1,195,234						1,195,234
1874	899,934						899,934
1875	881,166						881,166
1876	993,311						993,311
1877	1,014,754	10,375					1,025,129
1878	1,033,082	78,028					1,111,110
1879	1,130,019	245,672					1,375,691
1880	1,384,010	524,735					1,908,745
1881	1,579,834	726,671					2,306,505
1882	1,829,394	1,136,018					2,965,412
1883	1,305,364	1,047,863					2,353,227
1884	1,559,912	895,634	1,022	62,122			2,518,690
1885	1,430,862	690,435	119,590	227,075			2,467,962
1886	1,627,383	880,006	756,237	307,948			3,571,574
1887	1,851,717	1,199,343	1,285,265	394,910			4,731,235
1888	1,918,672	1,191,097	1,433,689	511,953			5,055,411
1889	2,631,026	1,876,157	2,147,923	864,508			7,519,614
1890	2,863,848	2,274,192	2,914,081	891,910			8,944,031
1891	2,778,482	1,856,124	2,041,754	945,105			7,621,465
1892	2,848,552	2,402,195	3,058,176	1,226,220	29,245		9,564,388
1893	2,064,827	1,563,049	1,466,815	815,735	684,194		6,594,620
1894	1,935,379	1,255,255	1,523,451	1,055,229	1,913,234		7,682,548
1895	1,982,080	1,794,970	2,625,475	1,027,103	2,839,350		10,268,978
1896	2,418,846	1,763,235	2,100,398	1,200,907	3,082,973		10,566,359
1897	2,673,785	1,767,220	2,163,088	1,381,278	4,220,151		12,205,522
1898	2,987,930	2,275,664	2,552,205	1,125,538	4,837,971		13,779,308
1899	3,634,596	3,281,422	2,725,648	1,643,984	6,517,305		17,802,955
1900	3,945,068	3,680,738	3,104,033	1,675,949	8,158,450		20,564,238
1901	3,597,089	3,697,408	3,041,869	1,805,996	9,303,541		21,445,903
1902	3,734,712	4,421,250	3,683,792	2,057,532	13,080,118		26,977,404
1903	3,686,214	4,093,320	3,422,341	1,918,584	13,452,812		26,573,271
1904	2,465,448	2,871,130	2,132,898	1,056,430	11,672,405		20,198,311

[1] U. S. Geol. Survey Mineral Resources, 1882, p. 116, 1883.

[2] Idem, 1891, pp. 39–41, 1893.

Production of Lake Superior iron ore, 1854–1914, by ranges, in long tons—Continued.

Year.	Marquette.	Menominee.	Gogebic.	Vermillion.	Mesabi.	Cuyuna.	Total.
1905	3,772,645	4,472,630	3,344,551	1,578,626	20,156,566	.....	33,325,018
1906	4,070,914	4,962,357	3,484,023	1,794,186	23,564,891	.....	37,876,371
1907	4,167,810	4,779,592	3,609,519	1,724,217	27,245,441	.....	41,526,579
1908	3,309,917	2,904,011	3,241,931	927,206	17,725,014	.....	28,108,079
1909	4,291,967	4,789,362	3,807,157	1,097,444	27,877,705	.....	41,863,635
1910	4,631,427	4,983,729	4,746,818	1,390,360	30,576,409	.....	46,328,743
1911	3,743,145	4,062,778	3,099,197	1,336,938	23,126,943	181,224	35,550,225
1912	3,545,012	4,465,466	3,926,632	1,457,273	32,604,756	369,739	46,368,878
1913	3,977,808	4,997,246	4,743,515	1,536,115	36,378,671	744,007	52,377,362
1914	3,320,763	3,671,499	4,601,240	1,362,416	19,808,434	776,051	33,540,403
Total	112,448,191	93,587,876	82,904,333	36,400,797	338,856,579	2,071,021	666,268,797

SHIPMENTS AND RECEIPTS OF LAKE SUPERIOR IRON ORE.

According to the Iron Trade Review 32,729,726 long tons of iron ore were shipped in 1914 from the Lake Superior district, including the Iron Ridge area in Wisconsin, compared with 49,947,116 tons in 1913. Of the 1914 total 707,829 tons were shipped by rail, the remainder being by boat; 876,638 tons were shipped by rail in 1913. The shipments from the Lake Superior iron-ore ranges and the Iron Ridge area as reported to the Survey in 1914 amounted to 32,423,422 long tons. This quantity is 0.94 per cent less than the tonnage published by the Iron Trade Review.

The following tables give the details of shipments and receipts of Lake Superior iron ore by ports for the last six years:

Shipments of Lake Superior iron ore, 1909–1914, in long tons.[a]

Shipping port.	1909	1910	1911	1912	1913	1914
Escanaba, Mich	5,747,801	4,959,726	4,278,445	5,234,655	5,399,444	3,664,451
Marquette, Mich	2,909,451	3,248,516	2,200,380	3,296,761	3,137,617	1,755,726
Ashland, Wis	3,834,207	4,094,374	2,429,290	4,797,101	4,338,230	3,363,419
Two Harbors, Minn	9,181,132	8,271,177	6,367,537	9,370,969	10,075,718	5,610,262
Superior, Wis	6,540,505	8,414,799	9,920,490	14,240,714	13,788,343	11,309,748
Duluth, Minn	13,470,503	13,640,166	6,934,269	10,495,577	12,331,126	6,318,291
Total by lake	41,683,599	42,628,758	32,130,411	47,435,777	49,070,478	32,021,897
Total by rail	903,270	813,639	662,719	785,769	876,638	707,829
Total	42,586,869	43,442,397	32,793,130	48,221,546	49,947,116	32,729,726

[a] Iron Trade Review.

Iron-ore receipts at Lake Erie ports, 1909–1914, in long tons.[a]

Port.	1909	1910	1911	1912	1913	1914
Toledo	1,374,224	1,225,202	493,345	1,411,278	1,084,215	773,711
Sandusky	11,088	.....	.....	.....	.....	.....
Huron	243,082	197,951	223,947	540,586	687,485	617,363
Lorain	2,796,856	2,884,738	2,937,605	3,771,350	3,709,213	1,677,988
Cleveland	6,051,342	6,344,943	4,584,211	7,914,836	8,812,583	5,519,698
Fairport	1,734,277	1,516,434	666,365	1,810,381	2,037,126	1,558,134
Ashtabula	8,056,941	9,620,638	6,359,131	8,158,080	8,336,126	5,318,788
Conneaut	7,007,834	6,309,548	6,931,278	7,839,831	7,849,303	6,263,480
Erie	1,235,057	942,592	289,400	547,067	713,904	260,991
Buffalo	5,002,235	4,704,439	2,802,976	5,060,642	5,506,691	2,913,273
Detroit	159,889	296,412	243,292	418,057	363,001	332,564
Port Colborne, Ontario, Canada	.....	.....	.....	.....	.....	166,665
Total	33,672,825	34,042,897	25,531,550	37,472,108	39,099,647	25,402,655

[a] Iron Trade Review.

The difference between the shipments of Lake Superior ore and the receipts at Lake Erie ports is accounted for mainly by the quantity of ore delivered at Lake Michigan ports, South Chicago, Ill., Gary and Indiana Harbor, Ind., and Milwaukee, Wis., the receipts at which ports and at a number of smaller places are shown in the table following. It is understood that there is also a loss, approximating 1 per cent, in handling ore between mines and lower Lake ports.

Iron-ore receipts at Lake Michigan ports, 1910–1914, in long tons.[a]

Port.	1910	1911	1912	1913	1914
Elk Rapids, Mich	60,857	26,814	47,947	.....	28,437
East Jordan, Mich	37,910	36,232	42,878	28,444	38,158
Milwaukee, Wis	121,446	109,255	138,065	234,591	93,121
Gary, Ind	1,775,880	1,302,745	2,088,327	2,365,551	1,631,564
Indiana Harbor, Ind	287,172	365,312	514,748	455,252	661,054
South Chicago, Ill	5,080,679	3,685,100	5,480,105	5,572,866	3,606,587
Boyne City, Mich	50,355	33,000	45,000	45,028	50,098
Fruitport, Mich	37,785	.....	.....	.....	.....
Total	7,452,084	5,558,458	8,357,070	8,701,732	6,109,019

[a] Iron Trade Review.

The following table shows the total quantity of iron ore shipped from the Lake Superior district since 1854, the date of the opening of the Marquette range, the oldest of the Lake Superior ranges. This table gives the shipments as published by the Iron Trade Review and is inserted for comparison with the table giving the total production of the Lake Superior district, without regard to shipments:

Shipments of iron ore from the Lake Superior region, 1854–1914, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1854	3,000	1875	891,257	1896	9,934,828
1855	1,449	1876	992,764	1897	12,469,638
1856	36,343	1877	1,015,087	1898	14,024,673
1857	25,646	1878	1,111,110	1899	18,251,804
1858	15,876	1879	1,375,691	1900	19,059,393
1859	68,832	1880	1,908,745	1901	20,589,237
1860	114,401	1881	2,306,505	1902	27,571,121
1861	49,909	1882	2,965,412	1903	24,289,878
1862	124,169	1883	2,353,288	1904	21,822,839
1863	203,055	1884	2,518,692	1905	34,384,116
1864	243,127	1885	2,466,372	1906	38,565,762
1865	236,208	1886	3,568,022	1907	42,266,668
1866	278,796	1887	4,730,577	1908	26,014,987
1867	473,567	1888	5,063,693	1909	42,586,869
1868	491,419	1889	7,292,754	1910	43,442,397
1869	617,444	1890	9,012,379	1911	32,793,130
1870	830,940	1891	7,062,233	1912	48,221,546
1871	779,607	1892	9,069,556	1913	49,947,116
1872	900,901	1893	6,060,492	1914	32,729,726
1873	1,162,458	1894	7,748,932		
1874	919,557	1895	10,429,037	Total	656,485,060

STOCKS OF IRON ORE AT LAKE ERIE PORTS.

The following tables contain data as to the stocks of iron ore at the Lake Erie ports at the close of navigation and at the opening of navigation for the last six years:

Stocks of iron ore at lower Lake ports, Dec. 1, 1909–1914, in long tons.[a]

Port.	At close of navigation, Dec. 1—					
	1909	1910	1911	1912	1913	1914
Toledo, Ohio	332,456	433,215	661,382	552,016	349,047	580,600
Sandusky, Ohio	39,557	17,728	2,471	2,472	2,472	2,471
Huron, Ohio	477,333	375.118	344,371	385,810	441,541	483,769
Lorain, Ohio	407,129	259,448	314,321	320,713	694,704	548,097
Cleveland, Ohio	1,547,142	1,638,795	1,589,491	1,888,560	1,930,720	1,757,543
Fairport, Ohio	867,640	839,970	636,566	565,920	478,014	406,124
Ashtabula, Ohio	2,594,359	3,287,816	3,295,862	3,350,553	3,202,807	2,749,315
Conneaut, Ohio	1,411,002	1,329,997	1,237,573	1,429,533	1,248,032	1,160,639
Erie, Pa	788,046	792,011	636,274	661,330	594,613	484,467
Buffalo, N. Y	501,125	452,783	413,353	340,261	319,726	234,880
Total	8,965,789	9,426,881	9,131,664	9,497,168	9,261,676	8,407,905

[a] Iron Trade Review.

Stocks of iron ore at lower Lake ports, May 1, 1910–1915, in long tons.[a]

Port.	At opening of navigation, May 1—					
	1910	1911	1912	1913	1914	1915
Toledo, Ohio	366,631	383,761	356,102	394,984	215,534	255,343
Sandusky, Ohio	22,468	11,458	2,471	2,485	2,741	2,471
Huron, Ohio	336,693	273,042	257,496	293,006	308,478	462,917
Lorain, Ohio	205,445	346,849	287,294	399,705	245,057	377,550
Cleveland, Ohio	985,725	1,476,278	1,363,696	1,428,306	1,487,292	1,592,783
Fairport, Ohio	541,299	633,485	381,705	357,995	245,038	283,591
Ashtabula, Ohio	1,444,102	2,255,066	2,108,749	2,105,817	2,187,622	1,963,233
Conneaut, Ohio	461,365	419,421	229,462	135,100	495,153	564,077
Erie, Pa	550,187	653,778	585,150	449,455	461,750	412,186
Buffalo, N. Y	364,336	325,356	309,120	139,624	271,492	178,152
Total	5,278,251	6,778,494	5,881,245	5,706,477	5,920,157	6,092,303

[a] Iron Trade Review.

PRICES OF LAKE SUPERIOR IRON ORE.

In the following table are given the prices of Lake Superior iron ore at the lower Lake ports from 1890 to 1915, according to the Iron Trade Review.

The base for the old range and Mesabi Bessemer ore is a metallic iron content of 55 per cent; that of the old range and Mesabi non-Bessemer ore is a metallic iron content of 51.5 per cent.

Selling price of iron ore at lower Lake ports, 1890–1915, at date of buying movement.[a]

Season.	Date buying movement.	Season iron-ore prices			
		Old range Bessemer.	Mesabi Bessemer.	Old range non-Bessemer.	Mesabi non-Bessemer.
1890	Dec. 15, 1889	$5.50	No sale.	$5.25	No sale.
1891	June 1, 1891	4.50	No sale.	4.25	No sale.
1892	Jan. 31, 1892	4.50	No sale.	3.65	No sale.
1893	Mar. 15, 1893	3.85	$3.00	3.20	No sale.
1894	Mar. 1, 1894	2.75	2.35	2.50	No sale.
1895	Apr. 1, 1895	2.90	2.15	2.25	$1.90
1896	May 1, 1896	4.00	3.50	2.70	2.25
1897	May 20, 1897	2.60	2.25	2.15	1.90
1898	Mar. 20, 1898	2.75	2.25	1.85	1.75
1899	Feb. 1, 1899	3.00	2.40	2.15	2.00
1900	Dec. 15, 1899	5.50	4.50	4.25	4.00
1901	Apr. 15, 1901	4.25	3.25	3.00	2.75
1902	Feb. 1, 1902	4.25	3.25	3.25	2.75
1903	Mar. 20, 1903	4.50	4.00	3.60	3.20
1904	Apr. 15, 1904	3.25	4.00	2.75	2.50
1905	Feb. 1, 1905	3.75	3.50	3.20	3.00
1906	Dec. 5, 1905	4.25	4.00	3.70	3.50
1907	Nov. 5, 1906	5.00	4.75	4.20	4.00
1908	June 15, 1908	4.50	4.25	3.70	3.50
1909	May 10, 1909	4.50	4.25	3.70	3.50
1910	Dec. 24, 1909	5.00	4.75	4.20	4.00
1911	Apr. 21, 1911	4.50	4.25	3.70	3.50
1912	Mar. 20, 1912	3.75	3.50	3.00	2.85
1913	Nov. 19, 1912	4.40	4.15	3.60	3.40
1914	May 1, 1914	3.75	3.50	3.00	2.85
1915	Apr. 19, 1915	3.75	3.45	3.00	2.80

[a] Iron Trade Review.

IRON MINING IN MINNESOTA.

Commenting on the situation in the Minnesota portion of the Lake Superior district during 1914, Estep [1] says:

In a season in which ore shipments fell off nearly 35 per cent compared with the year before to a point over 15 per cent below the average for the previous 10 years, developments of unusual interest would not ordinarily be expected. Although this was the condition of affairs in the Lake Superior iron-ore industry in 1914, the year nevertheless was replete with interesting changes and events. The readjustments resulting from the lack of activity in themselves presented many intricate problems to the mine operators. In every direction organizations have been curtailed to the minimum, but at the same time it has been necessary to retain a certain nucleus from which to rebuild when the demand for ore improves. Owing to the large amount of ore which they control and the termination of the Hill lease by the United States Steel Corporation, the activities of the Great Northern ore trustees have been watched with unusual interest. Scarcely less interesting are the steps that have been taken by the Oliver Iron Mining Co., a subsidiary of the Steel Corporation, to provide an adequate supply of ore for the future needs of the world's greatest steel manufacturer. In addition, attention has been directed to questions of taxation, concentration, ore reserves, stock pile tonnages, and readjustments in wages, and prices of mine supplies. For a number of reasons particular interest also has been centered on the activities on the Cuyuna range.

From this article the following notes are taken:

The shipments of the Oliver Iron Mining Co. to the plants of the United States Steel Corporation aggregated 61 per cent of the total ore shipments from the Minnesota ranges. This large percentage was due partly to the fact that the Steel Corporation makes little or no pig iron for sale at its northern furnaces and therefore was able to maintain its mining activities on a better basis than some of the

[1] Estep, H. C., A review of interesting developments of the past year on Minnesota iron ranges: Iron Trade Rev., Jan. 7, 1915, pp. 73–81.

independent operators, who depend largely on merchant blast furnaces for the consumption of their ore, and who suffered because there was a relatively small demand for pig iron. The showing of the steel companies not affiliated with the Steel Corporation is also particularly commendable, when the general business conditions are considered. The Great Northern Railway carried the bulk of the ore traffic in 1914, and its shipments showed relatively little loss owing to the provision that all ore mined by the Steel Corporation on the Hill lease should be shipped over the Great Northern, but the shipments over some of the other roads in Minnesota showed a large shrinkage.

The year 1914 witnessed the final shipments of iron ore by the Steel Corporation under the lease of certain Great Northern properties. The Great Northern holdings were estimated to contain more than 400,000,000 tons of iron ore on January 1, 1914. It appears probable that the Great Northern ore will be marketed in the near future both through mining companies controlled by the Great Northern trustees and through leases to independent mining companies. A total of nearly 68,500,000 tons of ore have been shipped from the Great Northern properties, of which more than 29,600,000 tons were mined by the Steel Corporation. Notwithstanding the large production heretofore maintained and the enormous ore tonnage still in reserve, it is not probable, according to Mr. Estep, that the entry of the Great Northern ore into the general market will result in depressing or even in prolonging indefinitely the present low prices of iron ore, because only a small fraction of the vast tonnage of Great Northern ore is developed to the shipping point, and because the present low mining costs should more than offset the cost of carrying ore in stockpiles for one or two seasons.

To replace iron-ore properties relinquished by the cancellation of the Great Northern leases, the Oliver Iron Mining Co. has been developing several new properties, and is considered, therefore, to have more ore available for immediate mining and shipment than ever before, besides maintaining carefully its ore reserves. Details concerning these developments will be found in the article referred to above.

With regard to ore reserves it is stated that the estimates of ore on the Mesabi range prepared by the Minnesota Tax Commission show a decrease for the first time. The estimate of available tonnage of merchantable ore in the ground December 31, 1914, was 1,397,910,482 tons, compared with 1,406,499,614 tons December 31, 1913. The decrease thus is 8,589,132 tons, or about 0.06 per cent of the estimated reserves December 31, 1913. This decrease, while relatively insignificant, indicates that the heavy shipments of the last few years are beginning to affect the reserves. During the season of 1914, however, there was little exploration work in progress, and in more active seasons sufficient new ore may be found to compensate for the losses in the visible supply.

With regard to the concentration of ore during the year, Estep says:

> In connection with figures regarding ore reserves, it should be borne in mind that a very large tonnage in the western end of the Mesabi range must be concentrated by washing before it is available for shipment. As is well known, considerable development in the erection of concentrating plants already has taken place. During the past season the Oliver Iron Mining Co. shipped 1,574,835 tons of concentrates

from its Trout Lake plant. The International Harvester Co., which operates a one-unit plant near Nashwauk, shipped 229,608 tons of concentrates. The results obtained from the latter plant were particularly satisfactory, the iron recovery being 63 per cent, with from 9 to 10 per cent water in the concentrate. The moisture in the raw ore amounts to about 14 per cent. The ore is delivered to the bins at the International Harvester Co.'s plant at O'Brien Lake by a 36-inch conveyor belt, which runs 240 feet per minute on a 19° angle. It has been found that the belt will handle about 625,000 tons of ore before it must be replaced. The ore is concentrated to contain 60 per cent iron, dry analysis. * * * Butler Bros., St. Paul, have built a small washing plant near Nashwauk. It is of the standard type. The Cleveland Cliffs Iron Co. also is considering the erection of a plant in connection with the Crosby mine, in the same district.

At the La Rue mine, at Nashwauk, operated by M. A. Hanna & Co., Cleveland, an experimental washing plant was constructed and tried out during the past season. About 25,000 tons of ore was treated and the results are said to be successful. The plant was designed to use less water than the so-called standard plants. It includes a Woodbury jig operated in connection with a log washer and a Wetherbee concentrator.

M. A. Hanna & Co. operated the ore drier at the Brunt mine, near Mountain Iron. It handled 130,000 tons of ore, this being about 50 per cent of its capacity. The moisture in the ore was reduced from 18 to approximately 8 per cent.

In addition to wet and sandy ores, the Mesabi range contains almost incalcuable quantities of low-grade iron-bearing material, which at some future date might be utilized for the manufacture of pig iron. Looking in this direction, some interesting experiments were made at the plant of the American Ore Reclamation Co., Birdsboro, Pa., on a shipment of 1,500 pounds of a typical Mesabi range paint rock containing 40.5 per cent iron in its natural state. Although the results of these experiments were somewhat indeterminate, they are of interest in showing the efforts that are being made to recover various classes of iron-bearing material. The details of the work on paint rock were given in the June 18 issue of the Iron Trade Review.

The following discussion of the Cuyuna range is also of such interest that it is quoted in its entirety:

Conditions on the Cuyuna range deserve special mention on account of some unfortunate circumstances which have been connected with that district. In common with other new mining districts, the Cuyuna range has been obliged to go through a wildcat boom period, which it is now hoped is past.

The harmful effects of this exploitation were increased through the promotion of a number of alleged manganese-ore mines, in connection with the curtailment of the supply of ferromanganese due to the war in Europe. During the year the Minnesota Tax Commission made a careful estimate of the tonnage and quality of the ore available on the Cuyuna range. The commission was confronted by estimates of from 400,000,000 to 500,000,000 tons or over, made by newspapers, promoters, alleged experts, and speculators. One property alone was repeatedly reported to contain over 200,000,000 tons. Few of the operators or owners would, or indeed could, properly estimate their developed tonnage, and the commission called for complete exploration and drill reports and mine maps. Then it made its own measurements or calculations to determine all grades and classes of ore. The result was that the commission has determined that there are 70,857,865 tons of merchantable ore and 13,907,949 tons of low-grade iron and manganiferous ore material on the Cuyuna range. No commercial manganese ore has been developed on the range. There is a considerable quantity of manganese, but it is so mixed with the iron formation as to make it a manganiferous iron ore material of no present metallurgical value. The tax commission placed an assessment on 13 active mines, or those about to become mines, on the range, containing 30,356,975 tons; on 19 properties of reserve ore of the first class, containing 27,066,558 tons; on 15 properties of reserve ore of the second class, containing 13,434,332 tons; on 35 properties containing 13,907,949 tons of low-grade nonmerchantable or nonmineable iron. The total assessed valuation of the ore tonnage and mineral lands of the Cuyuna range was placed at $6,005,776. This represents 50 per cent of the true value of the property.

In spite of the conscienceless manner in which some properties on the Cuyuna range have been promoted, tangible legitimate progress is being made. This is attested by the shipment records of the past three years. In 1911 the Cuyuna shipped 147,431 tons; in 1912 it forwarded 305,111 tons; in 1913 the shipments rose to 733,021 tons; and in 1914, in spite of bad business conditions, they increased to 859,226 tons. The older mines on the range, including the Kennedy, the two Armours, the Thompson, [the] Rowe, and [the] Pennington, are now on a fully developed basis. Among the new

properties which are being developed, mention should be made of the Croft property, controlled by John A. Savage, Duluth. Shaft sinking is in progress at this mine and will be continued throughout the winter. The Brainerd-Cuyuna shaft at Brainerd is said to be down over 60 feet. At the Rowe mine, where hydraulic stripping operations were continued during the past season, a steam shovel now is operating. M. A. Hanna & Co. have given up the lease of the Barrows mine west of Brainerd, after shipping 56,438 tons from the property. Difficulties were encountered from the intrusion of seams of quartz in the ore deposit. The quartz is crushed when the ore is blasted and can not be removed except by washing. Similar quartz veins are said to have been discovered in several other Cuyuna properties, materially interfering with the mining operations.

FOREIGN TRADE IN IRON ORE.

IMPORTS.

The quantity of iron ore imported into the United States in 1914 was 1,350,588 long tons, valued at $4,483,832, or $3.32 a ton. This represents a decrease in quantity of 1,244,182 tons, or 47.95 per cent, and in value of $3,852,987, or 46.22 per cent, as compared with the imports during 1913, which were 2,594,770 long tons, valued at $8,336,819, or $3.21 a ton. As to the source of the imports in 1914 Cuba produced approximately 60 per cent of the ore, Sweden 21 per cent, Spain 5 per cent, Canada 4 per cent, with minor quantities from Newfoundland and Labrador, Venezuela, French Africa, United Kingdom, Greece, Egypt, Germany, and other countries.

The statistics of imports of iron ore are compiled from the records of the Bureau of Foreign and Domestic Commerce, and the following table gives the imports from the various countries from 1911 to 1914:

Quantity and value of iron ore imported into the United States in the calendar years 1911–1914, by countries, in long tons.

Country.	1911		1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cuba	1,147,879	$3,218,485	1,398,593	$3,969,986	1,635,622	$4,864,186	815,017	$2,288,102
Spain	194,965	502,453	92,061	222,951	112,580	488,798	66,982	233,287
French Africa	4,443	13,068	.....	.....	12,950	32,299	46,175	114,781
Greece	13,200	18,888	.....	.....	9,200	12,952	.....	.....
Newfoundland and Labrador	174,853	286,997	145,355	217,087	213,468	325,230	38,515	57,681
United Kingdom	1,436	19,725	10,229	20,587	10,431	24,726	2,663	52,814
Germany	2	76	1,729	5,602	1,323	6,223	2,256	9,222
Netherlands	223	420	5	72	.....	.....	.....	.....
Canada	50,480	106,038	106,675	201,882	179,860	409,098	52,514	153,415
Belgium	.....	.....	.....	.....	6	30	.....	.....
Russia in Europe	.....	.....	3,916	16,709	.....	.....	.....	.....
Sweden	219,238	1,215,588	333,863	1,781,579	356,074	1,901,988	280,887	1,481,747
Other countries	5,013	30,898	12,150	63,235	[a] 63,256	[a] 271,289	[b] 45,579	[b] 92,783
Total	1,811,732	5,412,636	2,104,576	6,499,690	2,594,770	8,336,819	1,350,588	4,483,832

[a] Of this, 57,225 tons, valued at $216,852, was from Venezuela and 4,400 tons, valued at $46,718, was from Egypt.

[b] Of this, 2,400 tons, valued at $3,600, was from Venezuela; 35,180 tons, valued at $41,760, was from Chile; and 6,050 tons, valued at $40,039, was from French Oceania.

The following table shows the imports of iron ore into the United States from 1911 to 1914, by ports of entry:

Quantity and value of iron ore imported into the United States in the calendar years 1911–1914, by customs districts, in long tons.

Customs district.	1911		1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Baltimore	806,354	$2,305,042	840,488	$2,359,765	1,076,452	$3,186,388	514,878	$1,431,539
Boston	100	272	98	252	.....	.....	.....	.....
New York	11,263	32,077	826	3,191	19,336	60,404	23,370	97,707
Philadelphia	984,192	3,039,994	1,229,737	4,072,776	1,393,096	4,809,961	762,958	2,769,599
San Francisco	10	250	.....	.....	50	168	22	377
Buffalo:								
Buffalo Creek	2,730	5,255	283	1,367	5,944	26,723	225	914
Niagara	1,668	8,343	810	3,818	2,137	11,332	.....	.....
Genesee	13	527	27	1,130	3,501	9,981	10,138	36,133
St. Lawrence:								
Champlain	146	1,904	30	660	620	2,540	.....	.....
Oswegatchie	50	150	.....	.....	.....	.....	99	717
Ohio:								
Cuyahoga	2,902	6,675	3,113	5,448	75,556	184,401	.....	.....
Erie	.....	.....	.....	.....	.....	.....	37,566	108,545
Miami	.....	.....	28,958	50,677	17,116	38,302	.....	.....
Detroit	23	105	.....	.....	.....	.....	63	280
Vermont	47	188	206	606	577	4,445	219	955
St. Louis	70	1,034	.....	.....	.....	.....	.....	.....
Mobile	.....	.....	.....	.....	.....	.....	1,050	37,066
Other districts	2,164	10,820	.....	.....	385	2,174	.....	.....
Total	1,811,732	5,412,636	2,104,576	6,499,690	2,594,770	8,336,819	1,350,588	4,483,832

In the following table are shown the annual imports of iron ore into the United States as far as recorded. Iron ore was imported from Europe in large quantities for the first time in 1879, most of the ore prior to that date coming from Canada:

Imports of iron ore into the United States, 1872–1914, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1872	23,733	1887	1,194,301	1903	980,440
1873	45,981	1888	587,470	1904	487,613
1874	57,987	1889	853,573	1905	845,651
1875	56,655	1890	1,246,830	1906	1,060,390
1876	17,284	1891	912,864	1907	1,229,168
1877	30,669	1892	806,585	1908	776,898
1878	28,212	1893	526,951	1909	1,694,957
1879[a]	150,197	1894	167,307	1910	2,591,031
1879[b]	284,141	1895	524,153	1911	1,811,732
1880	493,408	1896	682,806	1912	2,104,576
1881	782,887	1897	489,970	1913	2,594,770
1882	589,655	1898	187,208	1914	1,350,588
1883	490,875	1899	674,082		
1884	487,820	1900	897,831	Total	34,381,888
1885	390,786	1901	966,950		
1886	1,039,433	1902	1,165,470		

[a] Fiscal years end. [b] Calendar years begin.

EXPORTS.

The quantity of iron ore exported from the United States in 1914 amounted to 551,618 long tons, valued at $1,794,193, or $3.25 a ton, as compared with 1,042,151 long tons, valued at $3,513,419, or $3.37 a ton, in 1913. This represents a decrease in quantity of 490,533 long tons, or 47 per cent, and in value of $1,719,226, or 49 per cent.

In the following table are shown the exports of iron ore from the United States, by customs districts, from 1911 to 1914. The data regarding exports are compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Quantity and value of iron ore exported from the United States in the calendar years 1911–1914, by customs districts, in long tons.

Customs district.	1911		1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ohio							280	$1,000
New York	10	$68			22	$206		
Norfolk and Portsmouth	37	357	2	$18				
Saluria	4,175	9,412						
Buffalo	2,115	10,575			43,373	130,065	1,616	4,040
Champlain	13,583	49,278	19,200	76,359	36,778	147,331		
Duluth	75,232	265,360	165,420	579,586	402,557	1,426,586	284,569	972,293
Niagara	369	1,550	94	330	83	678		
Michigan	657,895	2,286,908	991,437	2,841,677	525,348	1,740,573	249,226	775,625
Washington	14,970	29,940	19,570	39,125	33,990	67,980	15,925	41,225
Baltimore			1	4			2	10
North Dakota and South Dakota			18	190				
Total	768,386	2,653,448	1,195,742	3,537,289	1,042,151	3,513,419	551,618	1,794,193

The quantity of iron ore exported from the United States, so far as recorded, is shown in the following table:

Exports of iron ore from the United States, 1899–1914, in long tons.

Year.	Quantity.	Year.	Quantity.
1899	40,665	1908	309,099
1900	51,460	1909	455,934
1901	64,703	1910	748,875
1902	88,445	1911	768,386
1903	80,611	1912	1,195,742
1904	213,865	1913	1,042,151
1905	208,017	1914	551,618
1906	265,240		
1907	278,608	Total	6,363,419

IRON-ORE INDUSTRY OF CUBA.

The iron ore shipped from Cuba in 1914 amounted to 821,110 long tons, valued at $2,378,130, compared with 1,582,431 long tons, valued at $4,505,504, in 1913, a decrease in quantity of 761,321 tons, or 48 per cent, and in value of $2,127,374, or 47 per cent. The shipments for 1914 are the lowest in any year since 1908. The shipments in 1914 consisted of 72 per cent of hematite, including a little magnetite, and 28 per cent of brown ore. The iron content of the hematite, dried at 212° F., ranged from 58.98 per cent to 59.87 per cent; the magnetic hematite carried about 57 per cent and the brown ore about 48.6 per cent of iron. The total stock of ore reported as on hand at the close of 1914 was 564,393 long tons, compared with 564,772 long tons at the close of 1913. This included both natural and nodulized ore.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the Cuban iron-ore shipments are collected by the United States Geological Survey.

Shipments of iron ore from mines in the Province of Oriente (Santiago), Cuba, 1884–1914, in long tons.

Year.	Juragua Iron Co. (Ltd.) (hematite and magnetite).	Sigua Iron Co. (hematite).	Spanish-American Iron Co.		Cuban Steel Ore Co. (hematite).	Ponupo Manganese Co., El Cuero iron mines (hematite).	Total.
			Daiquiri mines (hematite).	Mayari mines (brown ore).			
1884	25,295						25,295
1885	80,716						80,716
1886	112,074						112,074
1887	94,240						94,240
1888	206,061						206,061
1889	260,291						260,291
1890	363,842						363,842
1891	264,262						264,262
1892	335,236	6,418					341,654
1893	337,155	14,020					351,175
1894	156,826						156,826
1895	307,503		74,991				382,494
1896	298,885		114,110				412,995
1897	[a] 248,256		[b] 206,029				454,285
1898	83,696		80,225				163,921
1899	161,783		211,442				373,225
1900	154,871		293,195				448,066
1901	199,764		[c] 334,974		17,651		552,389
1902	221,039		455,105		23,590		699,734
1903	155,898		467,629				623,527
1904	31,162		356,111				387,273
1905	139,828		421,331				561,159
1906	133,379		507,195				640,574
1907	181,063		469,111				650,174
1908	366,580		254,256				620,836
1909	356,659		519,752			59,721	936,132
1910	318,814		670,976	307,700		165,008	1,462,498
1911	355,132		252,717	387,791		168,074	1,163,714
1912	360,094		463,533	446,176		127,994	1,397,797
1913	369,213		591,322	491,713		130,183	1,582,431
1914	267,641		284,507	228,949		40,013	821,110
Total	6,947,258	20,438	7,028,511	1,862,329	41,241	690,993	16,590,770

[a] Of this quantity, 5,932 tons were sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons were sent to foreign ports.
[c] Of this quantity, 12,691 tons were sent to foreign ports.

PRODUCTION OF IRON ORE IN PRINCIPAL COUNTRIES.

The latest available statistics of production of iron ore in the principal producing countries since 1910 are given in the accompanying table.

The figures are taken from the official publications of the following countries: Belgium, Canada, France, German Empire and Luxemburg, Italy, Spain, and the United Kingdom. The figures for Algeria and Tunis are taken from the official publication of the French Government; those for Cuba are collected by the United States Geological Survey; and those for the Philippine Islands are derived from the report of the Bureau of Mines, Manila, P. I. Otherwise, Mines and Quarries (the official British publication), London, is used except for 1913, for which year all foreign figures, except for Canada, Italy, and United Kingdom, are from Mineral Industry, New York.

In the original publications the statistics of many of the countries are given in metric tons, but these have for the sake of comparison been reduced to long tons.

Production of iron ore in principal countries, 1910–1914, in long tons.

Country.	1910	1911	1912	1913	1914
North America:					
Canada[a]	231,623	187,807	192,753	274,673	218,620
Cuba[a]	1,462,498	1,163,714	1,397,797	1,582,431	821,110
Newfoundland	1,108,762	1,171,992	1,251,968	(b)	(b)
United States	57,014,906	43,876,552	55,150,147	61,980,437	41,439,761
South America:					
Chile	.....	28,150	6,349	(b)	(b)
Europe:					
Austria-Hungary	4,592,572	4,779,851	4,997,311	5,018,109	(b)
Belgium	121,024	148,130	164,734	(b)	(b)
France	14,375,984	16,376,967	18,858,668	21,572,835	(b)
German Empire and Luxemburg	28,257,579	29,408,812	33,180,258	[c] 26,771,598	(b)
Greece	527,040	493,106	424,835	305,195	(b)
Italy	542,578	367,900	572,900	593,618	(b)
Norway	100,834	217,051	401,665	77,693	(b)
Portugal	3,307	19,233	28,947	48,407	(b)
Russia	(d)	(d)	(d)	(b)	(b)
Spain	8,530,310	8,635,523	[e] 8,990,743	9,706,366	(b)
Sweden	5,465,234	6,056,868	6,595,044	7,357,845	(b)
United Kingdom	15,226,015	15,519,424	13,790,391	15,997,328	(b)
Asia:					
China[f]	130,472	109,542	201,561	269,748	(b)
India	54,626	366,212	580,029	(b)	(b)
Japan	(g)	(g)	(g)	(b)	(b)
Chosen (Korea)	104,627	96,902	121,224	(b)	(b)
Philippine Islands	148	216	347	546	(b)
Africa:					
Algeria	1,048,228	1,057,087	1,171,252	(b)	(b)
Madagascar	(h)	(h)	22	(b)	(b)
Natal	50	.....	.....	(b)	(b)
Togoland	(b)	394	(b)	(b)	(b)
Tunis	327,756	397,638	470,866	(b)	(b)
Australia	157,821	122,361	113,989	(b)	(b)

[a] Shipments.
[b] Statistics not yet available.
[c] Germany alone. Figures not available for Luxemburg.
[d] Russia produced 2,936,024 long tons of pig iron in 1910, 3,536,417 tons in 1911, and 4,131,890 tons in 1912.
[e] Includes 1,563 long tons argentiferous iron ore, value $8,307.
[f] Exports.
[g] Japan produced 66,131 long tons of pig iron in 1910, 52,223 tons in 1911, and 55,379 tons in 1912.
[h] Nearly 8 tons of iron (metal) produced in 1910, and 1.5 tons in 1911.

BENEFICIATED IRON ORE.

An iron ore is said to be beneficiated if its quality is in any way improved by physical or chemical treatment. Thus the elimination of more or less of the foreign accessories, such as sand, clay, and water, with the result of increasing proportionately the percentage of iron, not only beneficiates the ore directly but, if done at the mine, lowers the cost of transporting the ore to the furnace. Merely changing the physical character or the chemical composition of the ore without eliminating any of the impurities may so improve its quality that it is more suitable for use in the blast furnace; therefore processes which produce such results may also properly be said to beneficiate the ore. There are many methods of improving the quality of iron ores, some of them very simple and even primitive and others rather complex and depending for their efficiency on large and expensive mechanical equipment, with all manner of gradations between the extremes. The methods and equipment employed depend, of course, largely upon the character of the ore and the nature of the problem to be solved.

According to Birkinbine [1] the usual forms of beneficiation practiced are:

(*a*) Hand picking or cobbing to separate that portion of the ore that is visibly of high grade from the poorer material.

(*b*) Drying, to remove excess moisture.

(*c*) Roasting, to remove moisture from hydrated ore and sometimes water combined mineralogically; to drive off carbonic acid from carbonate ores; to reduce the percentage of sulphur in some ores; to facilitate the removal of clay, rock, and sand; to make a nonmagnetic iron ore magnetic; and to improve the physical features of the ore.

(*d*) Washing, to reduce excessive clay, sand, and rock.

(*e*) Jigging, to accomplish the same results as washing but with finer material.

(*f*) Magnetic separation, to separate the strongly magnetic particles from those that are nonmagnetic, thus improving the character of the product.

(*g*) Agglomeration, to form finely divided material into lumps, either by briquetting, nodulizing, or sintering.

It is not the purpose of the present article to describe in detail the several processes mentioned above, although it is hoped that this important phase of the iron industry may at some future time be given greater attention in the series of iron ore reports in Mineral Resources. Reference is made elsewhere in this chapter to recent developments along this line on the Minnesota iron ranges. The reader who desires a concise outline of present practice will do well to consult the article by Birkinbine cited above.

Statistics of beneficiated iron ore were gathered by the Survey for the first time during the canvass for the year 1914, and, although it is not believed that complete returns were received from every producer who subjects his ore to any form of beneficiation, the responses to the special inquiries exceeded expectations and were, on the whole, satisfactory and interesting.

The following processes were reported as employed to improve the quality of the ore at various mines: Crushing and screening, drying by direct heat and by steam, hand picking on tables and on belts, washing by means of logs and by hydraulic jets, jigging, electromagnetic cobbing and separation, calcining, and nodulizing.

Iron ores were reported as beneficiated at 55 mines in 12 States, besides at the mines of the Spanish-American Iron Co. in Cuba. In Alabama the ore treated was brown ore and the usual process to which it was subjected was log washing. A total of 641,817 long tons of beneficiated brown ore valued at $955,035 was marketed from 9 mines in Alabama.

One mine in Connecticut, 2 in Georgia, and 1 in Massachusetts reported the concentration of small quantities of brown ore, resulting in an aggregate marketed product of 34,459 long tons, valued at $93,234.

Red hematite was beneficiated at 2 mines in Michigan and at 11 mines in Minnesota. Washing and drying were the principal processes employed, and the total marketed ore thus obtained amounted to 2,183,597 long tons, valued at $3,746,179.

[1] Birkinbine, J. L. W., Beneficiating iron ores: The A B C of iron and steel, chap. 2, p. 22, Penton Pub. Co., Cleveland, Ohio, 1915.

Three mines reported magnetic concentration of magnetite in New Jersey, and at one of these calcining was employed in addition. At one mine in North Carolina, which produces magnetite, the ore is subjected to a rough concentration consisting of electromagnetic cobbing. A total of 250,755 long tons of magnetite, valued at 715,999 was thus prepared for market in New Jersey and North Carolina.

In New York beneficiation of ore was reported by 8 mines. One of these mines produced red hematite, which was crushed and picked on a belt, and the rest produced magnetite. The magnetite was mainly concentrated magnetically, although at one mine only crushing and hand picking was reported. The total marketed hematite and magnetite treated in New York amounted to 519,743 long tons, valued at $1,567,753.

One mine in Pennsylvania reported washing red hematite in revolving screens, two mines reported washing brown ore, and at one mine the Gröndal concentrating process is employed. The marketed product of beneficiated ore from this State amounted to 157,920 long tons, valued at $337,295.

In Tennessee red hematite from the mines of the Rockwood-Cardiff area is improved by hand picking and breaking, and brown ore from four mines in the west-central belt is beneficiated. At two of these brown-ore mines washing is reported as the only method; the third reports hand picking, washing, and jigging; and the fourth reports the ore as washed and calcined. In all probability, however, hand picking is employed to a greater or less extent at nearly all brown-ore mines where the ore is mixed with gravel. Picking of the red hematite in the Rockwood-Cardiff area is a very simple process. At the Rockwood blast furnaces of the Roane Iron Co. each ore bin is provided just in front of the bottom with a horizontal steel plate about 3 feet wide and 3 feet 10 inches long on which ore may be drawn through a chute from the bin. An operative picks out the shale, which is the chief foreign material in the ore, cracking, if necessary, the large lumps with a hammer, throws the shale into a chute, and brushes the cleaned ore off the plate into chutes that dump into cars below going to the blast furnace skip. An important quantity of shale is thus removed from the ore. Another form of picking table is about 6 feet wide and 12 feet long, with its top composed of steel leaves, each about 1 foot wide, which extend across the table. These leaves can be opened and closed by means of a lever. This table is designed to stand on a framework directly over a railroad spur. Ore from the mine is dumped on the table, the shale is picked out and thrown to one side, and then by opening the leaves the ore is dumped into railroad cars directly below. The total beneficiated iron ore marketed in Tennessee in 1914 was 183,780 long tons, valued at $249,422.

Eight mines reported beneficiation of brown ore in Virginia in 1914, the total marketed output of ore treated being 158,227 long tons, valued at $335,890. Washing, screening, and jigging were the methods employed in treating this ore.

The brown ores of Mayari Province, Cuba, have been nodulized for many years at an extensive plant on Nipe Bay. The total quantity of this ore reported as marketed in 1914 amounted to 215,883 long tons.

The total beneficiated ore reported as marketed in the United States in 1914 amounted to 4,130,298 long tons, valued at $8,000,807. It was hoped that the statistics reported might contain more complete figures that would show the relation between crude ore treated and beneficiated ore recovered. These figures, however, were rather fragmentary, owing to the fact that at most brown-ore mines and many red-ore mines only the cleaned ore is weighed. The most complete figures submitted were those for magnetite. From such figures as are available, however, it is apparent that in washing brown ore the ratios, by weight, of crude ore washed to resulting concentrates range from 3:1 to 1.4:1; in concentrating red hematite, the ratios range from 2.34:1 to 1.06:1, and in magnetite they range from 2.7:1 to 1.08:1.

The following table recapitulates the State totals discussed above:

Marketed production of beneficiated ore in the United States, 1914, by States, in long tons.

State.	Variety.	Quantity.	Value.
Alabama	Brown ore	641,817	$955,035
Michigan, Minnesota	Red hematite	2,183,597	3,746,179
New Jersey, North Carolina	Magnetite	250,755	715,999
New York	Red hematite and magnetite.	519,743	1,567,753
Pennsylvania	Red and brown hematite and magnetite.	157,920	337,295
Tennessee	Red and brown hematite.	183,780	249,422
Virginia	Brown ore	158,227	335,890
Connecticut, Georgia, Massachusetts	Brown ore	34,459	93,234
Total		4,130,298	8,000,807

INVESTIGATIONS OF IRON ORE BY THE UNITED STATES GEOLOGICAL SURVEY.

GENERAL STATEMENT.

In 1914 the United States Geological Survey carried on special investigations of deposits of iron ore in Alabama, Georgia, Louisiana, Minnesota, and Texas.

The work in Minnesota was an investigation of the Cuyuna range in cooperation with the Minnesota Geological Survey. The Federal Survey was represented by E. C. Harder and the State Survey by A. W. Johnston. The work is expected to continue for several years, but no report has yet been published on its progress.

The field investigations of red iron ores in Alabama, Georgia, and Tennessee, by E. F. Burchard were completed in the spring of 1915. The latest papers that have been published on this area are the reports by the State Survey,[1] and the preliminary report of the United States Geological Survey.[2]

The studies in Louisiana were confined chiefly to Bossier, Caddo, and Webster parishes in the northwestern part of the State, and in Texas they comprised a reconnaissance of deposits of brown ore in several counties in the northeastern part of the State. This work

[1] Burchard, E. F., The red iron ores of east Tennessee: Tennessee Geol. Survey Bull. 16, 173 pp., 1913.
[2] Burchard, E. F., Preliminary report on the red iron ores of east Tennessee, northwest Alabama, and northeast Georgia: U. S. Geol. Survey Bull. 540, pp. 279–328, 1914.

was done by E. F. Burchard, and reports of the results and conclusions have been published.[1]

The leading facts presented in these two papers are summarized in the following paragraphs:

IRON ORE IN NORTHEASTERN TEXAS.

COUNTIES CONTAINING DEPOSITS.

Deposits characterized as brown iron ore have been noted by the Texas Geological Survey in the following 21 counties in northeastern Texas: Anderson, Camp, Cass, Cherokee, Gregg, Harrison, Henderson, Hopkins, Houston, Marion, Morris, Nacogdoches, Panola, Rusk, Sabine, San Augustine, Shelby, Smith, Upshur, Van Zandt, and Wood. Foremost among the counties that contain promising deposits of brown ore are Cass, Morris, Marion, and Cherokee.

TOPOGRAPHIC AND GEOLOGIC RELATIONS.

The surface of northeastern Texas represents a plateau 450 to 600 feet above sea level that has been moderately dissected by erosion to depths of 200 to 400 feet. Much of the surface is gently rolling, with shallow stream valleys, but the highest portions of the former plateau are now flat-topped ridges with steep slopes incised by sharp ravines. These flat-topped ridges are generally narrow and crooked, with spurs or branches extending from the main ridge. In places, however, they widen out into level areas a mile or more in width. These high-level areas are particularly well developed in Cherokee County. They represent remnants of the former plateau surface, and owe their existence to the greater resistance to erosion afforded by certain beds of hard sandstone and limonite with which they are capped.

The iron ore is found in the Cook Mountain and Mount Selman formations, of the Claiborne group, of early Tertiary (Eocene) age. The iron-bearing formations are composed of sand and clay, indurated and altered greensand, lenses of lignite, and lenses and concretions of limonite. These deposits lie nearly flat, but the dip in large areas is toward the south-southeast at a low angle.

All the deposits of iron ore, including both limonite and iron carbonate, so far as observed by the writer, are associated with glauconitic sand. Where the sand becomes less glauconitic the deposits become leaner in iron, and in beds that are composed only of silica sand no ferruginous deposits that could be termed iron ore are found. Iron pyrite has been observed in the unoxidized zone, but in relatively minute quantities, and to it directly can not be ascribed so important a part in the genesis of the ore as is evidently played by glauconite. The proximate source of the iron is believed to be the ferruginous sands and clays that inclose the ores, but it is probable that the ores themselves assumed their present form after the Claiborne sediments were deposited and had become a land area. All the ore material may have passed through the carbonate stage before becoming oxidized, but there is evidence that some of the limonite deposits near the surface are migrating downward through solution and redeposition.

[1] Burchard, E. F., Iron ore in Cass, Marion, Morris, and Cherokee counties, Tex.: U. S. Geol. Survey Bull. 620, pp. 69-109 (Bull. 620-E); Iron-bearing deposits in Bossier, Caddo, and Webster parishes, La.: U. S. Geol. Survey Bull. 620, pp. 129-150 (Bull. 620-G).

FORMS OF DEPOSITS.

Both the brown ore and the iron carbonate occur in nodular and geodal forms segregated in glauconitic sand and clay in thin lenses and irregular ledges, and the brown ore occurs also as more or less honeycombed thin sheets and layers, as fine fragments, crusts, small isolated nodules, and irregular masses of almost endless variety. Unconsolidated material, residual from the breaking down of such masses, are found in many places at the surface. The brown ore occurs also, particularly in central Cherokee County, in a rather persistent, laminated bed, 1.5 to 4 feet thick, near the top of the highest table-land. Another common form of ferruginous deposit is the conglomerate that outcrops on the sides of many stream valleys and is even in process of formation in certain stream beds to-day. This conglomerate occurs as local masses composed of pebbles of sandstone—more or less ferruginous itself—pebbles of limonite, with here and there a few white quartz pebbles and angular fragments of silicified wood, the whole being cemented together by limonite. Bowlders of this conglomerate reach thicknesses of more than 2 feet in places, but it can not be considered as an iron ore.

The principal forms of the iron-bearing deposits may be summarized as:

1. Residual, unconsolidated deposits of limonite.
2. Nodular, geodal, and concretionary masses of limonite and iron carbonate.
3. Laminated beds of limonite.
4. Ferruginous conglomerate.

TYPICAL DEPOSITS.

In Cass County important deposits of brown ore merging into iron carbonate below ground-water level have been opened on Bowie Hill and other places northwest of Atlanta, near Bivins, Linden, and Lasater. An almost endless variety of sections are displayed in the prospect pits and trenches, but it will suffice here to give in detail two sections shown in large prospect trenches near Linden. The deposit of ore shown in the first section, especially the top 7 feet, is one of the richest in the county. Others vary in richness according to the proportion of ore to the associated clay, sand, and gravel.

Section in large trench 9 miles southeast of Linden, Cass County, Tex.

	Ft.	in.
1. Soil rich in ore débris	1	0
2. Ledge of limonite with a few seams of sand	4	10
3. Glauconitic sand and clay		7–10
4. Limonite, in part concretionary		3– 8
5. Light-yellowish to reddish glauconitic sand		3
6. Limonite, in part concretionary		4– 7
7. Reddish glauconitic sand and white clay with few small nodules of limonite; the sand is partly indurated by ferruginous streaks	1	9
8. Limonite		2– 3
9. White and reddish glauconitic sand	1	11
10. Limonite lens, 3 feet long, in sand layer		4
11. Limonite with seams of indurated sand		10
12. Bluish-green clayey sand		3

Base concealed. Iron carbonate reported below.

A photograph of this prospect trench has been published.[1]

The section outlined above thus shows about 8 feet of ore in 13 feet of sediments.

In contrast with the richness of the section just given is the following section, shown at the face of a cut about 200 yards east of the large trench:

Section in prospect trench 9 miles southeast of Linden, Tex.

	Ft.	in.
1. Sand, light colored, mostly silica	1	6
2. Limonite		14–18
3. Reddish glauconitic sand with white clay streaks and streaks of limonite, ¼ to ½ inch thick	1	6
4. Limonite with streaks of sand		4– 5
5. Reddish glauconitic sand, cross-bedded and containing white streaks	1	11
6. Limonite		7
7. Yellowish sand		5
8. Limonite		2
9. Yellowish sand, cross-bedded		10
10. Limonite		4
11. Reddish glauconitic sand, cross-bedded and containing white clay streaks	3	7
12. Limonite		3
13. Reddish glauconitic sand, cross-bedded and containing white clay streaks	3	6

There are according to this section about 3 feet 2 inches of limonite within the 16 feet of sediments.

The important deposits in Marion County are near Lasater and southwest of Avinger, and in Morris County they are southwest of Daingerfield. The ore in these two counties is of the same general type as in Cass County, but the thickness of the iron-bearing deposits appears to become less south and west from that county. The iron-bearing deposits in the counties just mentioned belong to the Mount Selman formation.

The importamt brown iron ore deposits of Cherokee County are situated near the tops of the plateaus south of Jacksonville, those in the vicinity of Rusk probably being the most extensive and best known. They are regarded as belonging to the Cook Mountain formation, the upper of the two iron ore-bearing formations of the Claiborne group. The deposits in the vicinity of Rusk are of a type entirely distinct from those of Cass, Marion, and Morris counties. Instead of consisting of irregular, ramifying, and fragmentary masses of more or less nodulated ore distributed through 15 to 30 feet of beds, as in Cass County, the Rusk deposit consists essentially of one solid and fairly continuous bed of limonite, with no important residual concentration of ore above and but little ore in seams and nodules below. The limonite bed near Rusk forms a cap near the top of the flat-topped plateau at an altitude of about 600 feet and is overlain by unconsolidated gray sand ranging from 1 to 30 feet thick. Over areas comprising several square miles there are undulations in the altitude of the bed reaching a maximum of perhaps 30 feet.

The ore bed ranges from 7 to 8 inches to 3 and even 4 feet in thickness, but the more common thicknesses are between 1 foot 3 inches

[1] Linton, Robert, Texas iron-ore deposits: Eng. and Min. Jour., Dec. 20, 1913, p. 1153.

and 2 feet 6 inches. At the top of the ore bed, wherever exposed, is a "sand cap" or layer of more or less ferruginous hard sandstone from half an inch to 4 inches in thickness. This sand cap may be split freely from the ore in mining. The base of the ore bed is irregularly rounded and is underlain by a few inches of light-colored clay, below which are layers of sand and soft sandstone, some of which is glauconitic.

The ore itself possesses certain characteristics of texture and color that make it easily distinguishable from the ores of the more northerly counties. The color, for instance, is light brown or buff—several shades lighter than that of the ore of Cass County, except where the latter ore is ocherous. The upper 2 to 4 inches of ore generally has fine open laminæ, parallel to the bed, lined with glossy black coatings, with here and there a spot colored bright red. The ore below the laminated layer presents a curly structure when freshly broken, in contrast to the more evenly concretionary type of ore in Cass and Marion counties. The ore with curly structure cracks and crumbles on weathering and thus is known as "buff, crumbly" ore. Occasionally a cavity is found in the ore containing sand or sandy clay.

The Rusk ore is considered to carry a relatively high percentage of alumina, and there may be a relation between the presence of this ingredient and the light color of the ore. The ore from the top of the bed containing black-lined laminations is said by furnace men who have had experience in its use to contain a higher percentage of phosphorus than the rest of the ore in the bed.

COMPOSITION OF THE ORES.

The composition of the brown ores of northeastern Texas has been discussed by Phillips,[1] using data published in early reports of the Texas Geological Survey and many analyses made during the recent prospecting of the oil fields. From the article by Phillips the following data with regard to the ores are quoted:

In studying these analyses it was decided to divide them into four groups, e. g., from 40 to 45, 45 to 50, 50 to 55, and 55 to 60 per cent of iron. All ores containing less than 40 per cent of iron are disregarded. The time may come when such low-grade material may be used through processes of crushing, jigging, etc., but we need not concern ourselves with this now. We distinguish, then, four classes of these ores:

Medium, containing from 40 to 45 per cent of iron.
Good, containing from 45 to 50 per cent of iron.
Very good, containing from 50 to 55 per cent of iron.
Extra, containing from 55 to 60 per cent of iron.

It is probably the case that most of the so-called brown ores (and, with the exception of some carbonate ore, all of the east Texas iron ores are of this character) used in this country carry about 45 per cent of iron. It is an exception to the general rule when such ores carry as much as 50 per cent of iron, save when they are calcined, and this practice is not common. Such ores go direct from the washers to the stockhouse, a very small proportion being calcined or otherwise improved.

Cass County, 47 analyses:	Per cent.
Medium grade ore	29.8
Good grade ore	23.4
Very good grade ore	23.4
Extra grade ore	23.4

[1] Phillips, W. B., Iron and steel making in Texas, II: Iron Age, Jan. 11, 1912, pp. 141–143.

Average composition.

	Medium.	Good.	Very good.	Extra.	Average of all analyses.
Metallic ore	42.43	48.23	52.33	57.58	48.64
Silica	18.26	11.85	5.19	3.94	10.64
Alumina	11.33	7.85	5.21	5.21	7.65
Phosphorus	.108	.147	.107	.052	.103
Sulphur	.098	.133	.124	.065	.104

One sample, not included in this classification, contained iron 60.44, silica 3.50, phosphorus 0.038, sulphur 0.220.

Marion County, 65 analyses:	Per cent.
Medium grade ore	4.6
Good grade ore	15.4
Very good grade ore	9.3
Extra grade ore	70.7

Average composition.

	Medium.	Good.	Very good.	Extra.	Average of all analyses.
Metallic iron	43.18	46.69	53.80	57.43	54.91
Silica	19.55	13.10	4.99	3.27	5.18
Alumina	7.41	8.40	8.33	2.69	4.30
Phosphorus	Trace.	.093	.070	.081	.073
Sulphur	.030	.380	.156	.100	.067

In two of the good ores the silica was 26.43 per cent. In one the alumina was 19.96 per cent, and maximum sulphur was 0.735. In one sample of the very good ore the alumina was 16.50 per cent; the maximum sulphur was 0.304. The maximum phosphorus in one sample of the extra ore was 0.22 and the maximum sulphur was 0.22. This county has not only the highest average of extra ore, but the highest general average in metallic iron, viz, 54.91 per cent.

Morris County, 10 analyses:	Per cent.
Very good grade ore	50
Extra grade ore	50

Average composition.

	Very good.	Extra.	Average of all analyses.
Metallic iron	52.82	56.85	54.83
Silica	7.76	5.55	6.85
Alumina	4.99	3.39	4.19
Phosphorus	.132	.113	.125
Sulphur	.007	.011	.009

In the very good ores the maximum silica was 13.10, maximum alumina 6.84, and the maximum phosphorus 0.209. Considering that no analyses with less than 51 per cent of iron are quoted from this county it would appear that the best average of ore is from Morris County, although Marion County has the highest percentage of ore with more than 55 per cent of iron.

Cherokee County, 10 analyses:	Per cent
Medium grade ore	40
Good grade ore	60

Average composition.

	Medium.	Good.	Average of all analyses.
Metallic iron	42.34	46.18	44.64
Silica	22.62	17.19	19.01
Alumina	11.47	10.35	10.94
Phosphorus	.156	.140	.146
Sulphur	.227	.029	.117

In the medium ores the maximum silica was 25.13, the maximum alumina 23.41, the maximum phosphorus 0.315, and the maximum sulphur 0.607. In the good ores alumina was determined in only one sample. The maximum silica was 20.36 and the maximum phosphorus 0.284. * * *

Of the ores represented by these analyses about one-fourth are of medium grade, about one-fourth are good, nearly one-fifth are very good, and nearly one-third are of extra quality and carry from 55 to 60 per cent of iron. It has been already stated that the total area involved in these 14 counties is 10,640 square miles. This must not be taken to mean that all of this territory is ore-bearing. This is certainly not the case. Just how much of this area will be productive of workable ores of the medium good, very good, and extra grades is not now known. This is really the vital question and not what will be the average composition of the ores. There is a vast difference in so far as concerns shipments of these ores or even their use locally, between material carrying between 40 and 45 per cent of iron and material carrying between 50 and 55 per cent. This difference is acutely accentuated when we consider the ores of extra quality carrying from 55 to 60 per cent of iron. If the statement that nearly one-third of these ores are of extra quality be true (and we believe it to be so, within a reasonable degree of accuracy) we have in them the very best brown ores in the country. When one considers the easy reducibility of these ores and the cheapness with which they can be mined and handled, it may not be extravagant to say that they rank with the best ores of any kind, brown, hematite, or magnetite. What they lack in metallic iron would be more than counterbalanced by reduced cost in smelting.

It may, however, be urged that the extent of the deposits, of whatsoever grade, has not yet been definitely established. This same remark holds good for many other brown ore deposits, some of which have yielded a very large amount of ore. But while this is true, it does not affect the situation in Texas. That brown ore deposits elsewhere, which have not been thoroughly prospected in advance of the shovel, have yielded and are still yielding large tonnages is no proof that these deposits will also yield large tonnages.

In respect of brown ore it is particularly true that the "proof of the pudding is in the eating." Professor Pick-and-Shovel is the only competent instructor in this school.

PROSPECTING.

Many of the iron-ore deposits in northeastern Texas were worked on a small scale before and during the Civil War, but when the small local forges and furnaces dependent on them became inadequate to compete with larger plants in the Eastern States they fell into disuse. The ore was at first obtained from the most favorably exposed ledges by hand mining, and no thorough prospecting was undertaken until within the last decade. Recently, however, very thorough prospecting of large tracts in Cass, Marion, and Morris counties has been undertaken by several companies. A preliminary study of the land is first made, including examination of all the outcrops and natural sections of the iron-bearing sediments and testing by means of shallow pits and trenches, in order to determine, if possible, whether the expense of further investigations is warranted. If the indications are favorable, deeper prospecting may be done by means of test pits, open trenches, and drill holes.

The information to be derived from the prospecting supplemented by concentration tests and chemical analyses consists principally in determining (*a*) the thickness of the cover; (*b*) the total thickness of the ore-bearing ground; (*c*) the section, which shall show approxi-

mately the volume ratio of ore to barren material; (*d*) the weight ratio of ore to barren material; (*e*) the character of the ore itself.

In connection with the prospecting work there should be carried on a thorough system of recording the results—preferably one which shall show them in as graphic a way as possible. This is effected by running careful levels over the property, making a large-scale topographic map with 5-foot contour intervals, and plotting each test pit or drill hole accurately on this map. Cross-section sheets are also made, on which by means of appropriate patterns all the test openings are shown to scale in their relative altitudes, together with the materials passed through. Later, when concentration tests and ore analyses have been made, these data can be added to the cross-section sheets, and these, together with the topographic map, will contain all the essential data concerning each tested point on the property, and will enable a reasonably close estimate to be made as to the reserves of available ore and its grade.

In prospecting the laminated, bedded type of ore, such as occurs in Cherokee County, the problem is simpler than in prospecting the concretionary ores of the counties farther north. It is necessary to know the thickness of the cover above the ore, the thickness of the ore bed, its quality, and the altitude at which it lies. Since the bed outcrops at a nearly uniform level around the border of the plateau lands, generally on steep slopes, it is most conveniently prospected by pick and shovel on the outcrop. Drills might, however, be used on the level upland, but in places where the cover exceeds 10 feet in thickness mining could hardly be carried on under present conditions, and therefore systematic prospecting of such areas would be of little use.

CONCENTRATION OF ORE.

The profitable exploitation of the nodular, concretionary, and residual ores in Cass and the adjoining counties probably depends more on the successful concentration of these ores than on any other factors connected with their development. Heretofore hand picking of the lump ore from the surface has been about the only method of maintaining a high-grade product, but this method is wasteful and altogether too slow and expensive to be maintained. What is needed is a method or a combination of methods of ore concentration that should make it possible to work on a large scale the maximum thickness of ore-bearing ground and to deliver a high grade of ore concentrates at a cost commensurate with the value of the ore recovered.

Experiments are under way in Cass County which involve washing the mine-run ore in revolving screens, picking the oversizes on a picking belt, and crushing and jigging the residue when separated from the loose sand and clay. In commercial operations the ore will first be run through log washers. The final step consists in calcining the ore to drive off the combined water from the limonite and the carbon dioxide from the carbonate ore. The washing and jigging experiments, which have been carried on in a small, but well-equipped plant, have been designed mainly to ascertain the ratio of ore to dirt removed from the test holes, and, although not performed on a commercial scale, they seem to demonstrate that the ore can be fairly well cleaned by this method, the percentage of silica being materially reduced and the percentage of iron proportionately increased.

Surface water is none too abundant in this region at certain seasons of the year, and the maintenance of steady and adequate supplies of water for large operations may prove one of the most serious problems to be solved. There are many small creeks in the region which might be utilized to supply reservoirs, and the water, after having been used, can be conserved for further use by means of settling basins. Deep wells are also expected to play a part in furnishing water for ore washing.

For calcining ore the northeastern Texas district is well supplied with fuel. There is an abundance of wood at present, lignite occurs in many places, and the proximity of the Caddo oil and gas field is an advantage, as natural gas is already supplied from it to several towns in Cass County.

In 1914 an investigation was undertaken by Prof. William B. Phillips to ascertain whether a beneficiation process, known as the Goltra process, is applicable to the brown ores of northeastern Texas. By the Goltra process the use of water is dispensed with and the ore is cleaned by means of a current of hot air and properly located screens, and the fines are separated magnetically. The Goltra process is an air-washing process, instead of a water-washing process, and, instead of jigging, it employs magnetization and magnetic separation of the fine material.

A Goltra plant has been built at Waukon, Iowa, in an attempt to render marketable the brown ore occurring near that place. In order to test the Texas ores, Dr. Phillips shipped 14 carloads, aggregating about 338 tons, of Texas brown ore to Waukon and had it put through this concentrating process.

Of the results of this process Dr. Phillips [1] writes:

> What has been done, therefore, is to take a raw ore containing 32.74 per cent of iron and bring 46 per cent of it up to 52 per cent of iron. Taking the free and combined water as material which has to be removed and which represents no possibilities of concentration, being a detriment to the ore, we have taken a material which in the ground carries 32.74 per cent of iron, and have brought the iron up to 52 per cent. At the same time the physical nature of the ore has been greatly improved. The loss in weight during the operation, extending from the ore "bank" to the loading bins at the plant, is 54 per cent, of which 20 per cent is free and combined water. This leaves 34 per cent, or 115.13 tons of material, a portion of which may be suitable for further concentration.
>
> The finished product obtained by this process is excellently adapted for use in the blast furnace. The free and combined water are completely, and the clay, sand, etc., almost completely, removed. The sulphur, except in the case of some magnetic concentrates, is eliminated. The physical nature of the ore is greatly improved, particularly in respect to its porosity and easy reducibility in the blast furnace.

UTILIZATION OF THE ORE.

The brown ore of northeastern Texas has been utilized in a small way for the manufacture of iron in small local forges or furnaces in almost every county in which a fairly large deposit of the ore occurs. This form of industrial activity took place mainly between 1856 and 1870. Between 1870 and 1909 iron was manufactured from time to time in five or more small charcoal blast furnaces. One of them, at Rusk, was owned by the State of Texas, and made iron pipe from most of the output. Since the last of these furnaces went out of blast, several plans have been made to establish iron and steel works on the Gulf coast, as well as at points between the ore field and

[1] Phillips, W. B., Concentration by the Goltra process: Iron Age, Nov. 12, 1914, pp. 1148–1150.

the Oklahoma coking-coal field. The recent conditions of the iron and steel market and the general financial situation have not, however, been favorable for the furtherance of such ambitious enterprises, and in the meantime some attention has been given to the shipment of iron ore to blast furnaces in Alabama and on the Atlantic seaboard.

Phillips,[1] who has given much thought to the utilization of the brown ore of Texas, believes that the ore should be utilized within the State, but regards as impracticable at present the plan of building iron and steel works on the Gulf coast. With regard to a practicable iron and steel plant, Phillips says:

* * * Iron and steel works of the size to make profitable use of by-product ovens are not now needed in Texas or the Southwest. Instead, it seems to us that a blast-furnace plant producing 25 to 300 tons of pig iron a day with a steel plant whose product would enter into the lighter finished forms, is much more to the point. The initial investment would be much less and the character of the product could be kept in closer touch with actual demands. The logical location for such a plant would be in eastern or northeastern Texas in close proximity to the ore fields and within reach of the coking coal of Oklahoma and Arkansas. So far as known there is no good coking coal in Texas, and the nearer an iron furnace is to regular supplies of coke the better. Coking coal or coke will have to be brought from some other State. * * * The most favorable outlook in Texas and the Southwest for the manufacture of iron and steel is in the direction of a blast furnace with auxiliary steel plant, not operated so much with reference to the demand for the heavier forms, such as structural shapes, plates, or rails, as to the demand for cotton ties, wire fencing, wire nails, perforated metal, pipe, and light steel castings. That such an enterprise would succeed here, under proper management, is, we think, well within the bounds of probability.

About 1907–8 approximately 2,200 tons of brown ore (mostly from Marion and Cass counties) was shipped to the Birmingham district, Alabama, a distance by rail of about 500 miles. The ore was mostly in selected lumps and its average content of metallic iron was above 57 per cent, with phosphorus ranging from 0.10 to 0.20 per cent, and it was reported to be well adapted for the production of basic open-hearth steel. The freight rate was $2.20 a ton.[2]

In 1910 a sample shipment of 568 tons of brown ore was made to Philadelphia via Texas City on Galveston Bay. The rail haul was about 300 miles. The quality of ore was similar to that sent to Birmingham. A water rate of $2.30 a ton to Philadelphia is reported to have been quoted to one of the companies.[3]

Two steamer cargoes of high-grade brown ore (averaging about 57 per cent of iron) were shipped from northwestern Marion County to Philadelphia, via the Port Bolivar Iron Ore Railway, and the Santa Fe line to the Gulf, in the summer of 1913. The ore is reported to have proved entirely satisfactory in the Alan Wood & Iron Steel Co.'s furnaces where it was used.

With regard to the supply of the highest grade of ore, Phillips[4] says:

While it may not be possible to secure large and regular shipments of 57 per cent ore from eastern Texas, yet we believe there are very large supplies of 50 per cent ore which can be mined and loaded for 85 cents to $1 per ton. Such ore could be laid down in the stockyard of a furnace at Jefferson for $1.25 a ton, and at Texarkana for $1.50 a ton. The ore cost of a ton of pig iron should not exceed $3 at either of these localities.

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[1] Phillips, W. B., Iron and steel making in Texas, I: Iron Age, Jan. 4, 1912, pp. 14–16.
[2] Idem, p. 14.
[3] Linton, Robert, Texas iron-ore deposits: Eng. and Min. Jour., Dec. 20, 1913, pp. 1154–1156.
[4] Phillips, W. B., op. cit., p. 15.

IRON-BEARING DEPOSITS IN NORTHWESTERN LOUISIANA.

PARISHES CONTAINING DEPOSITS.

The bright red soil and the abundance of débris of limonite (hydrated iron oxide) in bowlders, slabs, and gravel on the summits and slopes of the hills in northwestern Louisiana have for many years given rise to the hope that at least some of the deposits of this useful mineral might eventually be found to be of value. An opportunity was presented for a Survey reconnaissance of these deposits in connection with those of northeastern Texas in the autumn of 1914, and accordingly the writer spent about two weeks in examining the most promising iron-bearing deposits in Bossier and Caddo parishes, besides certain deposits in De Soto and Winn parishes, before proceeding to Texas. Although little encouragement could be offered as a result of these examinations, it was believed that more definite information would be gained by prospecting in certain localities, and as the owners or trustees for these properties expressed a willingness to do the necessary prospecting, the localities were designated by the writer with suggestions for carrying out the work. After four weeks spent in a reconnaissance of the northeastern Texas field, the writer returned to Shreveport in order to examine the results of the prospecting. At this time a trip was also made to northern Webster Parish.

The limonite deposits of northern Louisiana are by no means confined to the five parishes mentioned. Limonite has been noted also in Bienville, Claiborne, Jackson, Lincoln, Ouachita, and Union parishes. It is believed, however, that the deposits in Bossier and Webster parishes are typical, if not the best representatives, of the iron-bearing deposits in northern Louisiana. Johnson, who had opportunity to study the field as a whole, regarded Bossier Parish 25 years ago as one of the most promising districts of the iron-bearing region,[1] and it is to-day even more certain that if the limonite deposits in northwestern Louisiana were of sufficient magnitude to be mined for iron ore those of Bossier Parish would be first to be drawn upon, as Shreveport would become the logical iron-manufacturing center. Therefore, if the most favorably situated deposits fail to meet the requirements of the iron industry, there would seem little need to extend the investigation further. A comparison between the characteristic limonite deposits of northwestern Louisiana and the productive deposits of northern Alabama is given on page 525, under "Conclusions," in order that the disparity between them may be readily appreciated.

FORMS OF DEPOSITS.

The forms in which limonite and other hydrated oxides of iron occur in this region are varied, but may be grouped under a few general types. Limonite is widely distributed in small quantities as a cementing material in sandstone, conglomerate, and breccia. Thus, it may be found in all stages from a thin, soft crust in the sands, in which the iron hydroxide is visible only as a faint stain, up to a massive hard bed, in which the iron-mineral appears to compose the major portion of the rock. To this type of deposit Johnson [2] has applied the

[1] Johnson, L. C., The iron regions of northern Louisiana and east Texas: 50th Cong., 1st sess., H. R. Ex. Doc. 195, 1888.
[2] Idem, pp. 24–25.

general term "impregnation" deposits, from the fact that the iron hydroxide has been carried into the beds in solution. Such deposits are being formed at the present time in the beds of streams near Bolinger, Shongaloo, and other places. Another common type of limonite is the nodular form, including concretions, geodes, and other modifications, such as are produced when a number of these forms are grown together into a honeycombed or cellular mass. Iron carbonate is sometimes found in nodules below ground-water level. Another type is a more or less compact layer or bed of limonite that may have been formed in a bog. The deposits of this type may vary greatly in purity. Still another type consists of limonite gravel, formed of the débris of former deposits at the same or higher levels. Gravel deposits are likely to be found on or near the tops of hills. In their general order of value these types might be summarized as follows, although local conditions may greatly influence the value of any particular deposit: (1) Nodular, (2) layer, (3) residual, (4) impregnation.

TOPOGRAPHIC AND GEOLOGIC RELATIONS.

The most conspicuous limonite deposits of Bossier, Caddo, and Webster parishes are situated on the plateaus and ridges that rise to heights of 100 to 300 feet above the low-water level of Red River, or 260 to 460 feet above sea level. In the northern part of Bossier Parish there is a crescent-shaped area of high, red-surfaced land extending from Phelps Lake to and beyond Rocky Mount, and there is a corresponding high area east of Bodcau Lake in the northern part of Webster Parish. The higher lands of Caddo Parish are in the southwestern part of the parish. There are two horizons at which limonite is commonly found, one at or near the tops of the plateaus and ridges, the other near the top of a terrace-like area between the Red River valley and the highest levels.

The rock formation in which the limonite deposits are situated are mostly unconsolidated sandy clay and sand, with a few beds of clay nearly free from sand, and local indurated lenses of ferruginous sandstone. In the reconnaissance made by the writer there was small opportunity for study of the local geology and, of course, none for mapping the formation boundaries. Probably, however, all the beds with which the limonite deposits are associated in the area under consideration, except those near Mooringsport, may be assigned to the St. Maurice formation,[1] of the Claiborne group, Eocene series, Tertiary system. The St. Maurice is regarded as the equivalent of the Mount Selman and Cook Mountain formations,[2] in which the limonite deposits in northeastern Texas are found. The beds near Mooringsport are in the Wilcox formation, which underlies the Claiborne group.

A small collection of fossils was obtained by the writer from a lenticular bed of concretionary limonite in the wagon-road cut in the SE. ¼ sec. 25, T. 20 N., R. 13 W., Bossier Parish. These fossils have been examined by William H. Dall, who reports that they are probably of lower Claiborne age.

[1] Harris, G. D., Oil and gas in Louisiana: U. S. Geol. Survey Bull. 429, 1910.
[2] Deussen, Alexander, Geology and underground waters of the southeastern part of the Texas Coastal Plain: U. S. Geol. Survey Water-Supply Paper 335, p. 51, 1914.

TYPICAL DEPOSITS.

On the high land between Bolinger and Phelps Lake limonite in some form may be found on nearly every section of land. Some of the deposits have been known for 40 years or more and others have been brought to notice through the extensive logging operations of the Bolinger Lumber Co. Typical of the best class of deposits are those indicated in the following sections:

Section in ravine cutting bluff facing Phelps Lake in NW. ¼ sec. 5, T. 22 N., R. 13 W., Bossier Parish, La.

	Ft.	in.
1. Red sandy loam, with slabs and bowlders of limonite on the slope from top of plateau	5–8	0
2. Limonite, dark brown, good quality, with mammillary surface and concretionary structure, but fairly free from cavities		9
3. Limonite, sandy		3–4
4. Red sandy loam and reddish, soft sandstone with a few scales of sandy limonite	4	0
5. Limonite, light brown, sandy in places, weathers shaly and shows ocherous layers. Forms an overhanging ledge	1	4
6. Gray and red slightly sandy clay, exposed for 15 to 20 feet, then covered and exposed only at two or three places	40	0
7. Hard ledge of ferruginous sandstone and breccia, exposed to bottom of small pool. The fragments are mainly angular pieces of ferruginous sandstone	3	9
8. Concealed by wash of sand and clay	96	0
9. Grayish soft laminated sand	15	0
10. Flood-plain deposits of fine sand, silt, and organic matter.		

Section in ravine cutting bluff facing Phelps Lake, in SW. ¼ sec. 32, T. 23 N., R. 13 W., Bossier Parish, La.

	Ft.	in.
1. Sandy soil on slope	5	0
2. Limonite, dark brown, generally compact and lustrous		10–16
3. Slope concealed by soil, vegetation, and limonite débris.	42	0
4. Limonite, dark brown, slightly concretionary, with mammillary top surface. Contains much lustrous, rich limonite, but some sandy nodules and streaks, and a few inclusions of ocherous material	1	1
5. Sandy clay, in part concealed	18	0
6. Limonite in slabs 3 to 4 feet in length. Top 7 inches of rich limonite with mammillary surface but lower half sandy. These slabs appear to be out of place and to have slumped down on their outer edges, due to the undermining of the underlying soft beds. Possibly they may represent bed 4. (Compare analyses Nos. 3 and 4, p. 524)		10–14
7. Clay and sandy beds, mostly concealed	35	0
8. Conglomerate and breccia of ferruginous sandstone cemented by limonite. At the top is a layer about 10 inches thick of shaly limonite and ocher, apparently a replacement of sandy shaly clay. Over the face of the bed where gullied out by wet weather stream is a sheet of porous limonite in process of deposition from chalybeate seepage	4	0

Section shown by prospect pits at Rocky Mount, Bossier Parish, La.

	Ft.	in.
1. Soil and limonite débris		1–2
2. Dark soil and roots		10–12
3. Reddish, sandy clay with two to four seams of dark, sandy limonite, one-fourth to one-half inch thick, coated with yellow sand that is sparingly glauconitic	6	0
4. Hard yellowish-red sand, slightly glauconitic	1+	
5. Dark hard sandy limonite (the sand runs in pockets)		6–10
6. Yellowish-red sand sparingly glauconitic with 2 or 3 seams of sandy limonite about half an inch thick	8	0
7. Sand, mostly silica, with some admixture of clay; color yellow, becoming lighter below	8	0
8. Sand similar to No. 7, becoming nearly white in lower part; carries a thin streak of sandy limonite	10–15	0

COMPOSITION OF THE ORE.

In the following table are arranged 15 analyses of limonite from northwestern Louisiana—11 from Bossier Parish, 3 from Caddo Parish, and 1 from Webster Parish. Eleven of the samples were collected by the writer in the autumn of 1914, and 4 of the analyses are republished from the paper by Johnson already referred to. Only the metallic iron was determined on sample No. 7. For convenience in comparison an analysis averaged from several hundred commercial analyses of washed brown ores produced in the Birmingham district, Alabama, is given as No. 16 in the table. It is of interest to note that 7 of the 15 Louisiana limonites carried more than the Birmingham average of metallic iron, while 3 others nearly approached this average, and if No. 7 be omitted the average of the remaining 14 samples is 45.3 per cent of metallic iron, or a trifle higher than the Birmingham average. The quality of the Louisiana ore may therefore be considered good, but the thicknesses compared in the table are not encouraging.

Analyses of limonite from Bossier, Caddo, and Webster parishes, La., and from Birmingham district, Alabama.

No.	Average thickness of deposit.	Metallic iron.	Insoluble (practically SiO_2).	Alumina.	Manganese.	Phosphorus.	Sulphur.	Loss on ignition.
	Inches.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	.....	38.35	21.40	.....	.....	0.18	0.34	.....
2	10	51.94	5.21	4.17	None.	1.15	.01	14.22
3	13	42.87	23.28	1.97	.20	.93	.02	11.94
4	12	40.95	23.85	3.31	None.	.99	None.	11.34
5	.....	49.97	12.15	.....	.....	.62	.08	.....
6	.....	43.21	19.15	4.51	None.	.26	.09	14.38
7	46	26.63	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
8	21	40.99	29.81	1.53	None.	.07	.06	10.90
9	8	36.86	35.55	2.23	None.	.24	.07	10.16
10	15	44.74	17.30	3.51	None.	.19	Trace.	16.71
11	7	48.92	13.16	2.77	None.	.16	.01	13.64
12	5	50.61	9.85	5.16	None.	.17	Trace.	13.64
13	.....	48.67	19.97	1.09	.45	.41	.20	8.33
14	.....	50.32	6.37	.....	.079	Trace.	.100	10.26
15	.....	45.72	18.72 (SiO_2)	.....	.007	.247	.170	11.25
16	.....	44.99	14.59	3.99	.74	.47	.....	5.40

1. From Millers Bluff, Bossier Parish, cited by L. C. Johnson, op. cit., p. 36.
2. From SW. ¼ sec. 32, T. 23 N., R. 13 W., Bossier Parish, bed No. 2. Analyst, W. C. Wheeler, U. S. Geological Survey.
3. From SW. ¼ sec. 32, T. 23 N., R. 13 W., Bossier Parish, bed No. 4. Analyst, W. C. Wheeler, U. S. Geological Survey.
4. From SW. ¼ sec. 32, T. 23 N., R. 13 W., Bossier Parish, bed No. 6. Analyst, W. C. Wheeler, U. S Geological Survey.
5. From SW. ¼ sec. 32, T. 23 N., R. 13 W., Bossier Parish (probably bed No. 2). Cited by L. C. Johnson op. cit., p. 37.
6. From SW. ¼ NW. ¼ sec. 28, T. 23 N., R. 13 W., Bossier Parish (old tramway cut). Analyst, W. C. Wheeler, U. S. Geological Survey. (Average of several seams, ½-inch to 4 inches thick.)
7. From NW. ¼ SE. ¼ sec. 19, T. 23 N., R. 13 W., Bossier Parish. Analyst, W. C. Wheeler, U. S. Geological Survey.
8. From SW. ¼ sec. 22, T. 23 N., R. 13 W., Bossier Parish. Analyst, W. C. Wheeler, U. S. Geological Survey.
9. From SW. ¼ sec. 17, T. 21 N., R. 12 W., Bossier Parish (Rocky Mount). Analyst, W. C. Wheeler, U. S. Geological Survey.
10. From SE. ¼ sec. 25, T. 20, R. 13 W., Bossier Parish. Analyst, W. C. Wheeler, U. S. Geological Survey.
11. From SE. ¼ sec. 18, T. 20 N., R. 12 W., Bossier Parish. Analyst, W. C. Wheeler, U. S. Geological Survey.
12. Geode from SW. ¼ sec. 3, T. 17 N., R. 16 W., Caddo Parish, near Greenwood. Analyst, W. C. Wheeler, U. S. Geological Survey.
13. From SW. ¼ sec. 3, T. 17 N., R. 16 W., (powder from geode interior) Caddo Parish, near Greenwood Analyst, W. C. Wheeler, U. S. Geological Survey.
14. From near Greenwood, Caddo Parish, cited by L. C. Johnson, op. cit., p. 49.
15. From near Shongaloo, Webster Parish, cited by L. C. Johnson, op. cit., p. 40.
16. From Woodstock and Champion areas, Birmingham district, Alabama. Average of several hundred analyses of washed brown ore shipped to blast furnaces, 1906–1908.

CONCLUSIONS.

In some parts of the United States considerable money has been spent in unprofitable prospecting for brown iron ore; in others, much has been lost in attempting to mine deposits whose value had not been demonstrated by prospecting. In certain of these places it was not possible to determine from a study of surface indications the true or probable conditions. In northwestern Louisiana, however, conditions are such that the geologist should have no great difficulty in appraising the limonite deposits, and it is with regret that, owing to their meagre thickness and areal extent, the writer is forced to the conclusion that these deposits offer little encouragement for development in the near future. If this conclusion prevents useless prospecting, the examination will not have been made in vain, although, of course, the result is disappointing to the community which had hoped for the development of a local iron-ore industry.

The tabular summary below permits of a rough quantitative comparison of the northwestern Louisiana limonite with the deposits that are being worked in northeastern Texas, and at Russellville, Woodstock, and Champion, in Alabama.

Summary of quantitative data of limonite deposits in northwestern Louisiana, north eastern Texas, and northern Alabama.

Locality.	Form of deposit.	Thickness.	Relative units of area.	Possible methods of working.
Northwestern Louisiana.	Residual limonite, débris, and soil.	Generally less than 1 foot.	Acres.	By hand, if at all.
	Concretionary layers.	A few inches to 1½ feet.		
Northeastern Texas.	Residual limonite, débris, and soil.	A few inches to 5 feet.	Hundreds of acres.	By hand, and, exceptionally, by steam shovel.
	Concretionary layers.	A few inches to 6 feet.		
	Laminated beds.	1 to 4 feet.		
Russellville, Ala.	Residual limonite, débris, sand, and gravel.	5 to 35 feet.	Square miles.	By steam shovel.
	Pockets of massive limonite.	10 to 25 feet.		
Woodstock, Ala.	Residual limonite, débris, sand, and gravel.	3 to 10 feet.	Square miles.	By steam shovel.
	Pockets of massive limonite.	10 to 80 feet.		
Champion, Ala.	Residual limonite, débris, sand, and gravel.	20 to 60 feet.	Hundreds of acres.	By steam shovel.
	Pockets of massive limonite.			

IRON AND STEEL INDUSTRY OF THE UNITED STATES.[1]

PRODUCTION, SALES, AND VALUE OF PIG IRON, BY STATES.

According to the Bureau of Statistics of the American Iron & Steel Institute, the production in 1914 of all kinds of pig iron, including such ferro-alloys as speigeleisen, ferromanganese, ferrosilicon, and ferrophosphorus, produced in blast furnaces as well as some that were electrically produced, was 23,332,244 long tons, compared with 30,966,152 tons produced in 1913, a decrease of 7,633,908 tons, or 24.65 per cent.

The United States Geological Survey regards as official the statistics of production of pig iron and ferro-alloys heretofore collected by the American Iron and Steel Association and, beginning with the last half of 1912, by the American Iron and Steel Institute; but it has been found necessary for the Survey also to make a statistical canvass of the pig-iron manufacturing industry in order to obtain the value of the product, the data for which can be obtained in no other way. It should be explained here that the only common term in which the production of diversified mineral products may be

[1] The statistics for all production of steel and the statistics for pig iron prior to 1912, except those of marketed production, were published in the annual reports of the American Iron & Steel Association; beginning with 1912, they are according to the Bureau of Statistics of the American Iron & Steel Institute.

expressed is that of value in dollars—at mine, quarry, or manufacturing plant—and in order that the mineral production of the United States may be summarized the value of each product must be obtained. It has been found more accurate and convenient to obtain the value of the pig iron corresponding to the quantity in tons sold or used rather than that corresponding to the actual production by the furnaces in a given year, and thus in collecting and publishing the statistics of quantity and value of marketed production of pig iron the Survey is not duplicating the labors of the American Iron and Steel Institute but, instead, is presenting additional data to the iron trade—data that are available only to the Survey.

The following table gives the total production of pig iron, by States, in 1913 and 1914, according to their rank each year.

Production of pig iron in 1913 and 1914, by States, in long tons.[a]

State.	1913			State.	1914		
	Rank.	Quantity.	Per cent-age.		Rank.	Quantity.	Per cent-age.
Pennsylvania	1	12,954,936	41.84	Pennsylvania	1	9,733,369	41.72
Ohio	2	7,129,525	23.02	Ohio	2	5,283,426	22.64
Illinois	3	2,927,832	9.45	Illinois	3	1,847,451	7.92
New York, New Jersey, Alabama	4	2,187,620	7.06	Alabama	4	1,826,929	7.83
Indiana, Michigan	5	2,057,911	6.65	New York, New Jersey	5	1,559,864	6.69
Wisconsin, Minnesota	6	1,775,883	5.73	Indiana, Michigan	6	1,557,355	6.67
Virginia	7	367,326	1.19	Wisconsin, Minnesota	7	329,526	1.41
Missouri, Colorado, California, West Virginia, Kentucky, Mississippi	8	341,815	1.10	Virginia	8	271,228	1.16
Maryland	9	324,263	1.05	Missouri, Colorado, California, West Virginia, Kentucky, Mississippi	9	267,777	1.15
Tennessee	10	315,731	1.02	Tennessee	10	236,393	1.01
Connecticut, Massachusetts	11	289,959	.94	Maryland	11	216,738	.93
	12	280,541	.91	Massachusetts, Connecticut	12	195,594	.84
	13	12,810	.04		13	6,594	.03
Total		30,966,152	100.00	Total		23,332,244	100.00

[a] Bureau of statistics of the American Iron and Steel Institute.

According to reports made to the United States Geological Survey by the manufacturers the marketed production of pig iron in 1914 amounted to 22,263,263 long tons, valued f. o. b. at the furnaces at $298,777,429, as compared with 30,388,935 long tons, valued at $458,342,345, in 1913, a decrease in quantity of 8,125,672 tons, or 26.74 per cent, and in value of $159,564,916, or 34.81 per cent. The average price per ton in 1914 was $13.42, and in 1913 it was $15.08, a decrease in 1914 of $1.66 a ton. These values represent the approximate price per ton f. o. b. at the furnaces; this approximate price eliminates freight costs, selling commissions, and other items, which are included in the market prices of certain grades of pig iron as published in the trade journals.

The marketed production of pig iron includes the metal produced from foreign as well as domestic ore. The quantity and value of pig iron derived from ore imported from Africa, Canada, Cuba, Newfoundland, Spain, Sweden, and Venezuela, although it consti-

tutes a very small percentage of the total production, is considerable, as the sales of this metal, derived from foreign ore, amounted in 1914 to 803,411 long tons, valued at $11,464,635, as compared with 1,243,901 tons, valued at $18,708,589, in 1913. In the manufacture in 1914 of the 803,411 long tons of pig iron, 1,449,593 long tons of foreign iron ore were reported to have been used, thus indicating an average pig-iron yield of 55.42 per cent as compared with the tonnage of imported ore. The pig iron containing no foreign ore marketed in 1913 represented 54.66 per cent of the available supply of domestic ore and zinc residuum.

The following table shows the quantity and value of pig iron, exclusive of ferro-alloys, marketed in the United States in 1913 and 1914, by States, together with the decrease and percentage of decrease in 1914:

Quantity and value of pig iron marketed in the United States in 1913 and 1914, by States, with decrease and percentage of increase 1914, in long tons.

State.	1913		1914		Decrease in 1914.		Percentage of decrease in 1914.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	1,924,762	$23,242,374	1,661,420	$17,481,828	263,342	$5,760,546	13.68	24.78
Illinois	2,892,263	45,796,966	1,793,714	24,382,458	1,098,549	21,414,508	37.98	46.76
Kentucky	59,071	950,484	57,687	706,120	1,384	244,364	2.34	25.71
Michigan	447,188	6,568,920	379,619	5,229,948	67,569	1,338,972	15.11	20.38
New York	1,967,449	30,203,673	1,357,575	19,353,309	609,874	10,850,364	31.00	35.92
Ohio	6,913,961	103,824,517	5,226,925	70,331,114	1,687,036	33,493,403	24.40	32.26
Pennsylvania	12,871,349	197,726,314	9,267,197	127,686,331	3,604,152	70,039,983	28.00	35.42
Tennessee	270,481	3,576,485	178,481	2,150,452	92,000	1,426,033	34.01	39.87
Virginia	380,508	5,310,167	197,981	2,481,197	182,527	2,828,970	47.97	53.27
Wisconsin	292,793	4,430,117	250,944	3,350,199	41,849	1,079,918	14.29	24.38
Other States[a]	2,369,110	36,712,328	1,891,720	25,624,473	477,390	11,087,855	20.15	30.20
Total	30,388,935	458,342,345	22,263,263	298,777,429	8,125,672	159,564,916	26.74	34.81

[a] 1913: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1914: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Jersey, and West Virginia.

The following table gives the annual average price per long ton of pig iron in the United States for the years 1889 to 1914. The prices prior to 1907 include the cost of transportation of some pig iron from blast furnaces to markets. Prior to 1910 the values of blast-furnace ferro-alloys are included. The extreme range in prices, from $9.76 in 1894 to $20.92 in 1902, is of interest. The lowest prices occurred in the years 1894 to 1898, and the highest range was in the years 1902 to 1907.

Average price per long ton of pig iron in the United States, 1889–1914.

1889	$15.78	1898	$9.90	1907	$20.56
1890	16.43	1899	18.00	1908	15.96
1891	15.50	1900	18.85	1909	16.25
1892	14.32	1901	15.25	1910	15.45
1893	11.90	1902	20.92	1911	14.07
1894	9.76	1903	19.12	1912	13.93
1895	11.14	1904	14.13	1913	15.08
1896	10.47	1905	16.63	1914	13.42
1897	9.85	1906	19.98		

The average price of pig iron per long ton, by States, from 1910 to 1914, according to the manufacturers' reports to the Survey, is given in the following table. This represents the price at the blast furnaces and does not include the prices of blast-furnace ferro-alloys.

Average price per long ton of pig iron in the United States, 1910 to 1914, by States.

State.	1910	1911	1912	1913	1914
Alabama	$12.25	$10.75	$10.75	$12.08	$10.52
Illinois	15.91	15.30	15.26	15.83	13.59
Kentucky	16.07	15.01	15.74	16.09	12.24
Michigan	16.62	15.34	14.30	14.69	13.78
New Jersey	15.88	(a)	(a)	(a)	(a)
New York	16.72	15.56	14.22	15.35	14.26
Ohio	15.29	13.68	13.07	15.02	13.46
Pennsylvania	15.84	14.23	14.60	15.36	13.78
Tennessee	12.99	11.56	12.29	13.22	12.05
Virginia	13.85	12.62	13.27	13.96	12.53
Wisconsin	15.77	15.51	14.33	15.13	13.35
Other States [b]	15.63	14.94	14.07	15.50	13.55
Total	15.45	14.07	13.93	15.08	13.42

[a] Included in "Other States."
[b] 1910: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1911, California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1912 and 1913: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1914: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Jersey, and West Virginia.

BLAST FURNACES.

The following table shows the number of blast furnaces in blast on June 30 and December 31 and the total number of stocks recorded for the years 1913 and 1914, but does not, of course, include the electric reduction furnace at Heroult, Cal.:

Record of blast furnaces in the United States, 1913 and 1914, by States.[a]

State.	Furnaces in blast June 30, 1913.	Dec. 31, 1913.			Furnaces in blast June 30, 1914.	Dec. 31, 1914.		
		In	Out.	Total.		In	Out.	Total.
Pennsylvania	117	78	83	161	76	63	96	159
Ohio	62	40	35	75	43	31	43	74
Illinois	23	11	15	26	12	7	19	26
Alabama	23	23	26	49	20	18	30	48
New York	20	12	16	28	13	12	15	27
Virginia	9	8	16	24	8	3	19	22
Tennessee	8	4	14	18	6	4	14	18
Colorado	3	1	5	6	2	2	4	6
Missouri	1	1	1	2	1	1	1	2
Oregon	0	0	1	1	0	0	1	1
Washington	0	0	1	1	0	0	1	1
California	0	0	0	0	0	0	0	0
Maryland	3	1	4	5	2	2	3	5
New Jersey	2	2	5	7	2	1	5	6
Wisconsin	5	4	3	7	3	3	5	8
Minnesota	1	1	0	1	1	0	1	1
Indiana	10	5	5	10	8	4	6	10
Michigan	9	10	5	15	8	9	5	14
West Virginia	3	1	3	4	1	1	3	4
Kentucky	2	1	7	8	1	1	5	6
Georgia	0	0	4	4	0	0	4	4
Texas	0	0	4	4	0	0	3	3
Mississippi	0	0	1	1	0	0	1	1
Connecticut	2	1	2	3	1	1	2	3
Massachusetts	1	1	1	2	0	1	1	2
Total	304	205	257	462	208	164	287	451

[a] From the Bureau of Statistics of the American Iron and Steel Institute.

MONTHLY PRODUCTION OF PIG IRON.

The accompanying diagram (fig. 5) illustrates the course of the manufacture of pig iron by months during the last seven years. The sudden decline in production of pig iron at the close of October, 1907, the low production during the first half of 1908, the slow recovery of activity in the last half of 1908, the hesitating conditions early in 1909, the steady and rapid increase in production during the last part of that year, the gradual, almost uninterrupted, decline throughout the year 1910, the moderate production during 1911, broken by alternating declines and recoveries, the rising production of 1912 and early 1913, the record production of more than 2,822,000 tons in May, 1913, the fairly high production until October, the sharp decline in the last two months of that year, and the declining monthly production during 1914 broken by feeble rallies in March and August are graphically indicated.

PRODUCTION OF PIG IRON BY GRADES.

The following table shows the production of the principal grades of pig iron in 1910 and 1911, according to the statistics of the American Iron and Steel Association, and for 1912 to 1914 as published by the American Iron and Steel Institute:

Production of pig iron in the United States, 1910–1914, by grades, in long tons.

Grade.	1910	1911	1912	1913	1914
Bessemer and low phosphorus	11,245,642	9,409,303	11,664,015	11,590,113	7,859,127
Basic (mineral fuel)	9,084,608	8,520,020	11,417,886	[a]12,536,693	[a]9,670,687
Forge pig iron	564,157	408,841	469,183	324,407	361,651
Foundry and ferrosilicon	5,260,447	4,468,940	5,073,873	5,220,343	4,533,254
Malleable	843,123	612,533	825,643	993,736	671,771
Spiegeleisen	153,055	110,236	96,346	110,338	79,935
Ferromanganese	71,376	74,482	125,373	119,405	106,083
White, mottled, direct castings, etc	81,159	45,192	54,613	71,027	49,736
Total	27,303,567	23,649,547	29,726,937	30,966,152	23,332,244

[a] Includes a small quantity of basic iron made with charcoal.

PRODUCTION OF PIG IRON ACCORDING TO FUEL USED.

In the following table are given the statistics of the American Iron and Steel Association showing the production of pig iron according to the fuel used in 1910 and 1911 and those of the American Iron and Steel Institute after 1912. The charcoal figures include small quantities of pig iron made with charcoal and electricity. The totals for each of the five years also include small quantities of ferro-alloys made with electricity, coke and electricity, etc.

Production of pig iron according to fuel used, 1910–1914, in long tons.

Fuel used.	1910	1911	1912	1913	1914
Bituminous, chiefly coke	26,257,978	23,141,296	29,132,733	30,326,130	22,976,856
Anthracite and coke	628,579	212,548	236,467	277,595	89,569
Anthracite alone	20,503	17,027	10,712	22,446	1,895
Charcoal	396,507	278,676	347,025	339,981	263,924
Total	27,303,567	23,649,547	29,726,937	30,966,152	23,332,244

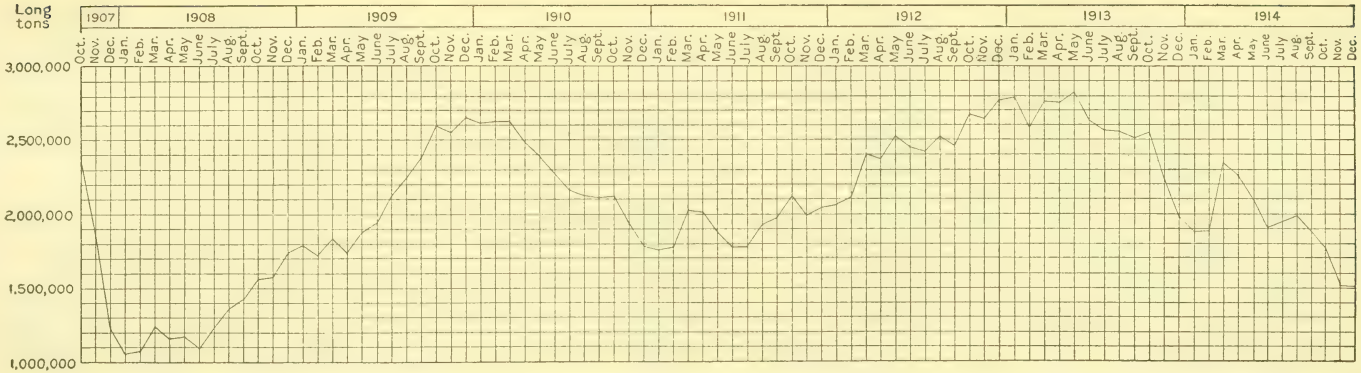

FIGURE 6.—Curve showing production of coke and anthracite pig iron in the United States from October, 1907, to December, 1914, by months. Tonnage according to the Iron Age.

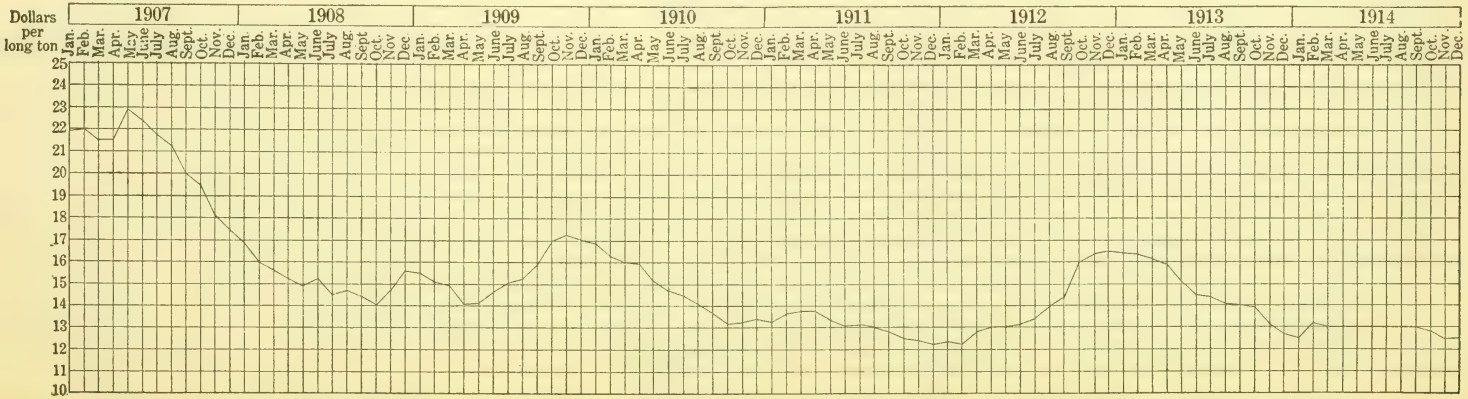

FIGURE 7.—Price curve of basic pig iron at Mahoning and Shenango Valley, Pa., furnaces, 1907 to 1914.. Prices according to the Iron Age, Jan. 7, 1915.

TOTAL PRODUCTION OF PIG IRON.

The following table shows the production of pig iron, including the production of the commoner ferroalloys, in the United States as far as has been recorded. The statistics for 1912 to 1914 are those of the American Iron and Steel Institute; those for years from 1854 to 1911 were collected by the American Iron and Steel Association; those for 1810, 1840, and 1850 are census figures; those for the other years are largely estimates by early statisticians.

Production of pig iron in the United States, 1810–1914, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1810	53,908	1865	831,770	1891	8,279,870
1820	20,000	1866	1,205,663	1892	9,157,000
1828	130,000	1867	1,305,023	1893	7,124,502
1829	142,000	1868	1,431,250	1894	6,657,388
1830	165,000	1869	1,711,287	1895	9,446,308
1831	191,000	1870	1,665,179	1896	8,623,127
1832	200,000	1871	1,706,793	1897	9,652,680
1840	286,903	1872	2,548,713	1898	11,773,934
1842	215,000	1873	2,560,963	1899	13,620,703
1846	765,000	1874	2,401,262	1900	13,789,242
1847	800,000	1875	2,023,733	1901	15,878,354
1848	800,000	1876	1,868,961	1902	17,821,307
1849	650,000	1877	2,066,594	1903	18,009,252
1850	563,755	1878	2,301,215	1904	16,497,033
1852	500,000	1879	2,741,853	1905	22,992,380
1854	657,337	1880	3,835,191	1906	25,307,191
1855	700,159	1881	4,144,254	1907	25,781,361
1856	788,515	1882	4,623,323	1908	15,936,018
1857	712,640	1883	4,595,510	1909	25,795,471
1858	629,548	1884	4,097,868	1910	27,303,567
1859	750,560	1885	4,044,526	1911	23,649,547
1860	821,223	1886	5,683,329	1912	29,726,937
1861	653,164	1887	6,417,148	1913	30,966,152
1862	703,270	1888	6,489,738	1914	23,332,244
1863	846,075	1889	7,603,642		
1864	1,014,282	1890	9,202,703	Total	519,988,398

MARKET PRICES OF PIG IRON.

In the following table are given the average monthly prices of the principal grades of pig iron either at the blast furnaces or at the nearest market, according to published market quotations. The accompanying diagram (fig. 7) graphically shows the price curve of basic pig iron at the Mahoning and Shenango Valley, Pa., blast furnaces, 1907 to 1914,inclusive.

Average monthly prices per ton of pig iron, 1913 and 1914, by months and kinds.[a]

Month.	1913				1914			
	Foundry pig iron at Valley furnaces.	Foundry No. 2 pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.	Foundry pig iron at Valley furnaces.	Foundry No. 2 pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.
January	$17.50	$13.72	$17.25	$16.45	$13.00	$10.63	$14.04	$12.33
February	17.12	13.46	17.25	16.32	13.21	10.52	14.23	13.06
March	16.60	13.04	17.25	16.06	13.25	10.75	14.17	13.04
April	15.66	12.60	17.01	15.71	13.25	10.52	14.00	13.00
May	14.73	11.74	16.78	14.90	13.17	10.50	14.00	13.00
June	14.18	10.89	16.24	14.50	13.00	10.29	14.00	13.00
July	13.88	10.50	15.41	14.23	13.00	10.06	14.00	13.00
August	13.94	10.85	15.66	14.05	13.00	10.00	14.00	13.00
September	14.00	11.20	15.75	14.14	13.00	10.00	14.00	13.00
October	13.83	11.48	15.70	13.71	12.89	10.00	13.94	12.85
November	13.57	10.80	15.13	13.01	12.75	10.00	13.64	12.48
December	13.38	10.50	14.84	12.52	12.75	9.65	13.75	12.50
Average	14.87	11.73	16.19	14.63	13.02	10.24	13.98	12.85

[a] Metal Statistics, New York, 1915.

The following table, compiled by the Iron Trade Review, summarizes the selling prices at Valley furnaces of Bessemer and Foundry No. 2 pig iron at the beginning of the buying season for the last 26 years:

Selling price of pig iron at date of buying movement.[a]

Season.	Date of buying movement.	Iron prices; Valley.		Season.	Date of buying movement.	Iron prices; Valley.	
		Bessemer.	Foundry iron No. 2.			Bessemer.	Foundry iron No. 2.
1890	Dec. 15, 1889	$22.15	$18.15	1903	Mar. 20, 1903	$21.50	$21.05
1891	June 1, 1891	15.15	15.00	1904	Apr. 15, 1904	13.35	13.15
1892	Jan. 31, 1892	15.00	13.65	1905	Feb. 1, 1905	15.50	16.00
1893	Mar. 15, 1893	12.65	12.15	1906	Dec. 5, 1905	17.25	17.25
1894	Mar. 1, 1894	9.65	9.60	1907	Nov. 5, 1906	21.50	21.50
1895	Apr. 1, 1895	9.40	9.45	1908	June 15, 1908	16.00	15.00
1896	May 1, 1896	12.40	11.15	1909	May 10, 1909	14.75	14.25
1897	May 20, 1897	8.35	8.40	1910	Dec. 24, 1909	19.00	17.25
1898	Mar. 20, 1898	9.55	9.80	1911	Apr. 21, 1911	15.00	13.75
1899	Feb. 1, 1899	10.30	9.75	1912	Mar. 20, 1912	14.25	13.25
1900	Dec. 15, 1899	24.15	22.15	1913	Nov. 19, 1912	17.25	17.50
1901	Apr. 15, 1901	16.15	14.40	1914	May 1, 1914	14.00	13.25
1902	Feb. 1, 1902	15.90	15.90	1915	Apr. 19, 1915	13.60	12.75

[a] Iron Trade Review.

FOREIGN TRADE IN PIG IRON.

IMPORTS.

The quantity of pig iron and ferro-alloys, the principal of which were ferromanganese, spiegeleisen, and ferrosilicon, imported into the United States in 1914 was 138,903 long tons, compared with 156,450 long tons imported in 1913, a decrease of 17,547 tons, or 11 per cent. The United Kingdom furnished the largest quantity in both years, with Canada, Germany, and the Netherlands following in order of importance in 1914.

The statistics of imports of iron are compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, and the following table gives the imports from the various countries from 1910 to 1914:

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States in the calendar years 1910–1914, by countries, in long tons.

Country.	1910	1911	1912	1913	1914
Austria-Hungary	6,069	590	400	340	899
Germany	7,417	4,286	5,924	8,358	10,609
Netherlands	15,737	9,719	492	460	2,539
United Kingdom: England	182,082	114,947	110,526	131,340	90,627
United Kingdom: Scotland				1,581	1,012
Canada	3,175	4,260	4,998	4,609	25,968
China	13,924	11,857	1,750	3,017	200
Belgium				256	500
France				179	40
Norway				117	225
Sweden				2,002	2,329
Switzerland				1,680	
Cuba				72	
British India				2,439	1,310
China, leased territory (British)					1,285
Italy					550
Australia and Tasmania					90
Newfoundland and Labrador					200
Hongkong					200
Peru					250
Japan					70
Other countries	8,829	2,800	5,235		
Total	237,233	148,459	129,325	156,450	138,903

EXPORTS.

The quantity of pig iron exported from the United States in 1914 was 114,423 long tons, compared with 277,648 long tons in 1913, a decrease of 163,225 tons, or nearly 59 per cent. The largest quantity was shipped to Canada, and important quantities were shipped also to England, Italy, Australia and Tasmania, and Panama. The iron trade with South American countries is very small.

The following table shows the exports of pig iron from the United States to the various foreign countries by calendar years from 1910 to 1914, according to records of the Bureau of Foreign and Domestic Commerce:

Pig iron exported from the United States to foreign countries, 1910–1914, in long tons.

Country.	1910	1911	1912	1913	1914
Canada	115,642	98,293	208,581	193,396	57,852
Austria-Hungary	1,050	.....	14,806	4,601	1,150
Italy	3,027	7,710	11,954	24,551	14,288
United Kingdom—England	3,994	8,526	25,617	20,972	18,013
United Kingdom—Scotland				396	148
United Kingdom—Ireland				26	.....
Germany	336	293	2,403	1,723	749
Belgium	189	622	1,698	4,715	1,219
France	48	202	827	752	397
Denmark	.....	125	168	48	.....
Mexico	719	444	804	85	454
Panama	400	1,079	1,606	3,921	1,056
Cuba	733	1,122	734	646	593
Brazil	.....	.....	50	1,305	575
Chile	100	600	1,964	690	1,875
Peru	550	875	835	172	200
Philippines	407	.....	259	54	57
Netherlands	.....	.....	.....	1,516	1,467
Portugal	.....	.....	.....	25	50
Costa Rica	.....	.....	.....	310	18
Honduras	.....	.....	.....	5	8
San Domingo	.....	.....	.....	40	.....
Argentina	.....	.....	.....	792	1,042
Colombia	.....	.....	.....	13	10
Uruguay	.....	.....	.....	112	100
Venezuela	.....	.....	.....	50	65
Japan	.....	.....	.....	2,293	2,938
Australia and Tasmania	.....	.....	.....	14,354	10,099
New Zealand	.....	.....	.....	85	.....
Other countries	190	908	370	.....	.....
Total	127,385	120,799	272,676	277,648	114,423

PRODUCTION OF PIG IRON IN PRINCIPAL COUNTRIES.

The following table is taken from "Metal Statistics." The grand totals are regarded as representing the world's production of pig iron, and the fact that the United States produces about 40 per cent of the total and yet exports relatively so little is of interest.

Production of pig iron in principal countries in 1850, 1890, 1900, 1910, 1912, and 1913, in long tons.[a]

Country.	1850	1890	1900	1910	1912	1913
United States	563,755	9,202,703	13,789,242	27,303,567	29,726,937	30,966,152
Germany	350,000	4,584,882	8,381,373	14,559,509	17,586,521	[b] 19,004,022
Great Britain	2,300,000	7,904,214	8,959,691	10,012,098	8,889,124	10,481,917
France	405,653	1,931,188	2,669,966	3,974,478	4,870,913	5,227,378
Russia	227,555	912,561	2,889,789	2,992,058	4,133,000	4,474,757
Austria-Hungary	250,000	910,685	1,472,695	2,153,788	2,276,141	2,335,170
Belgium	144,452	775,385	1,001,872	1,822,821	2,307,853	2,318,767
Canada	.....	19,439	86,030	740,210	912,878	1,015,118
Sweden	150,000	483,155	518,263	594,385	688,757	730,659
Spain	.....	176,598	289,315	367,423	[c] 402,209	[c] 402,209
Italy	.....	14,094	23,569	347,657	373,960	420,011
Japan	.....	.....	.....	186,794	200,709	[d] 200,709
Other countries [e]	10,000	80,000	100,000	250,000	350,000	450,000
Total	4,401,415	26,994,904	40,181,865	65,304,788	72,719,002	78,026,869

[a] Metal Statistics, 1915, p. 37, The American Metal Market Co., New York.
[b] Provisional.
[c] 1911.
[d] 1912.
[e] Estimated.

NOTE.—The estimate for 1914 is 64,000,000 long tons.

FERRO-ALLOYS.[1]

MARKETED PRODUCTION.

The United States Geological Survey undertook for the first time in the iron report for 1911 to present the statistics of production of ferro-alloys separately from those of pig iron, with which they had been previously included. Although the quantity of ferro-alloys reported is small, amounting to only about 1.15 per cent of the total marketed production of pig iron during 1914, the value per ton is so much greater as to have an important influence on the apparent value of the pig iron if included with it, making it $13.68 a ton instead of $13.42; therefore it has been decided to separate the two products.

There is generally a sufficient number of producers of the commoner ferro-alloys, such as ferromanganese, spiegeleisen, and ferrosilicon, to give the production of these three types of alloys separately; but the production of the rarer alloys, such as ferromolybdenum, ferrotitanium, ferrotungsten, and ferrovanadium, must be grouped together, and since there are less than three producers of ferrophosphorus the production of this alloy is grouped with that of ferrosilicon. It should be stated that the values of the first two groups of ferro-alloys were almost wholly estimated by the Survey for 1912 and 1913, but not for 1914, and the values of the rarer alloys have been estimated in part for all the years given.

The total marketed production of ferro-alloys in 1914, as reported to the United States Geological Survey, was 255,524 long tons, valued at $9,350,245, as compared with 296,207 long tons, valued at $13,015,362, in 1913. Of the production in 1914, 110,208 long tons, valued at $5,323,776, were made from imported ores derived from Brazil, India, and Russia. The ferrovanadium, ferromolybdenum, ferromanganese, spiegeleisen, ferrotitanium, and ferrotungsten were

[1] Notes on manganese ferro-alloys are also given in the chapter on the production of manganese and manganiferous ores in Mineral Resources for 1914.

made in part or wholly from imported ore. The quantity reported does not represent the total production of the United States, as the sales of considerable quantities of electrically produced ferro-alloys were not reported to the Survey.

The sales of ferromanganese and spiegeleisen in 1914 amounted to 177,356 long tons, valued at $6,026,392, compared with 226,475 long tons, valued at $9,272,269, marketed in 1913. The figures for ferromanganese and spiegeleisen, which may be shown separately for 1914, are as follows: Ferromanganese, 100,731 long tons, valued at $4,440,253; spiegeleisen, 76,625 long tons, valued at $1,586,139. The sales of ferrosilicon and ferrophosphorus in 1914 amounted to 77,182 long tons, valued at $1,621,830, compared with 67,164 long tons, valued at $1,233,465, in 1913. The sales of alloys of iron with the rarer metals molybdenum, titanium,[1] tungsten, and vanadium as reported to the Survey, amounted in 1914 to 986 long tons, valued at $1,702,023, compared with 2,568 long tons, valued at $2,509,628, in 1913, a decrease in quantity of 1,582 long tons and in value of $807,605. These alloys were therefore valued at an average price of more than $1,726 a ton in 1914, compared with $977 a ton in 1913.

The following table gives a very incomplete outline of the ferro-alloy sales in the United States in 1912, 1913, and 1914:

Marketed production of ferro-alloys in 1912, 1913, and 1914, in long tons.

Variety of alloy.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ferromanganese	227,939	$8,282,006	226,475	$9,272,269	100,731	$4,440,252
Spiegeleisen					76,625	1,586,139
Ferrosilicon	97,371	1,795,707	67,164	1,233,465	77,182	1,621,830
Ferrophosphorus						
Ferromolybdenum						
Ferrotitanium[a] (10 to 20 per cent titanium)	3,375	2,146,063	2,568	2,509,628	986	1,702,023
Ferrovanadium						
Ferrotungsten (above 50 per cent tungsten)						
Total	328,685	12,223,776	296,207	13,015,362	255,524	9,350,245

[1] No ferrotitanium reported in 1914.

IMPORTS.

According to the records of the Bureau of Foreign and Domestic Commerce, the imports for consumption of ferromanganese into the United States in 1914 were 82,997 long tons, valued at $3,619,607, as compared with 128,070 long tons, valued at $5,682,915, in 1913, and those of spiegeleisen in 1914 were 2,870 long tons, valued at $71,147, as compared with 77 long tons, valued at $2,173, in 1913. The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochrome are combined with those of chromium; those of ferromolybdenum are combined with those of the metal molybdenum; and those of ferrotungsten are included with those of tungsten. For the sake of comparison, however, such statistics as are available are presented in the following table:

[1] No ferrotitanium reported in 1914.

Ferro-alloys imported for consumption into the United States in 1912, 1913, and 1914, in long tons.

Ferro-alloy.	Value per ton.	1912		1913		1914	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Chrome or chromium and ferrochrome.	$200 or less	436	$47,179	(a)	(a)	(a)	(a)
	More than $200	38	30,408	(a)	(a)	(a)	(a)
Total		474	77,587	307	$31,415	200	$21,553
Ferrophosphorus	$200 or less	103	4,465			26	1,136
Ferrosilicon	15 per cent or less silicon.						
	More than 15 per cent silicon.	7,490	446,456	7,208	449,871	6,249	341,925
Ferrovanadium	More than $200						
Molybdenum and ferromolybdenum.	do	4	4,670	7	15,939	0.10	59
Titanium and ferrotitanium.	$200 or less	7	306				
	More than $200	16	7,325	15	7,198	18	8,356
Total		23	7,631	15	7,198	18	8,356
Tungsten and ferrotungsten.	More than $200	288	323,872	661	835,212	195	222,447
Ferromanganese		99,137	3,906,920	128,070	5,682,915	82,997	3,619,607
Spiegeleisen		1,015	28,094	77	2,173	2,870	71,147
Total		108,534	4,799,695	136,345	7,044,723	92,555.10	4,286,230

(a) Not separately stated.

PRODUCTION OF STEEL BY STATES AND KINDS.

The subjoined tables showing the production of steels were compiled by the American Iron and Steel Association prior to 1912 and by the Bureau of Statistics of the American Iron and Steel Institute since 1912.

The production of Bessemer steel ingots and castings in the leading States from 1910 to 1914 was as follows:

Production of Bessemer steel ingots and castings, 1910–1914, by States, in long tons.

State.	1910	1911	1912	1913	1914
Ohio	3,314,053	3,268,994	4,285,673	4,024,662	2,862,700
Pennsylvania	2,975,750	2,338,813	3,157,928	2,954,818	2,014,526
Illinois	1,693,053	1,335,053	1,559,576	1,475,274	871,110
Other States	1,429,916	1,004,994	1,324,724	1,090,952	472,510
Total	9,412,772	7,947,854	10,327,901	9,545,706	6,220,846

The following table gives the production of open-hearth steel ingots and castings in the leading States from 1910 to 1914:

Production of open-hearth steel ingots and castings, 1910–1914, by States, in long ton

State.	1910	1911	1912	1913	1914
New England States	223,158	189,879	214,325	195,419	137,962
New York and New Jersey	713,245	679,152	792,201	996,312	719,227
Pennsylvania	10,153,816	9,594,914	12,408,109	12,522,227	9,854,038
Ohio	1,733,409	1,721,549	2,565,343	2,726,219	2,592,778
Indiana	1,307,129	1,394,520	2,001,937	2,180,106	1,628,840
Illinois	995,011	801,624	1,235,166	1,264,854	896,610
Other States	1,378,741	1,217,012	1,563,642	1,714,794	1,345,229
Total	16,504,509	15,598,650	20,780,723	21,599,931	17,174,684

The following table gives the production, by States, of basic and acid open-hearth steel ingots and castings in 1913 and 1914:

Production of basic and acid open-hearth steel ingots and castings in 1913 and 1914, by States, in long tons.

State.	1913			1914		
	Basic open-hearth steel.	Acid open-hearth steel.	Total.	Basic open-hearth steel.	Acid open-hearth steel.	Total.
New England States	136,754	58,665	195,419	99,310	38,652	137,962
New York and New Jersey	919,506	76,806	996,312	658,599	60,628	719,227
Pennsylvania	11,578,352	943,875	12,522,227	9,178,064	675,974	9,854,038
Ohio	2,680,357	45,862	2,726,219	2,559,969	32,809	2,592,778
Indiana	2,116,261	63,845	2,180,106	1,570,404	58,436	1,628,840
Illinois	1,251,285	13,569	1,264,854	885,077	11,533	896,610
Other States	1,662,111	52,683	1,714,794	1,319,706	25,523	1,345,229
Total	20,344,626	1,255,305	21,599,931	16,271,129	903,555	17,174,684

The following table gives the production, by States and by processes, of all kinds of steel ingots and castings in 1913 and 1914:

Production of all kinds of steel ingots and castings in 1913 and 1914, by States, in long tons.

State.	1913				1914			
	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.
Massachusetts, Rhode Island, and Connecticut	2,476	195,419	2,716	200,611	2,200	137,962	1,521	141,683
New York and New Jersey	371,372	996,312	39,032	1,406,716	128,185	719,227	34,382	881,795
Pennsylvania	2,954,818	12,522,227	77,249	15,554,294	2,014,526	9,854,038	56,212	11,924,776
Delaware, Maryland, District of Columbia, Virginia, West Virginia, Kentucky, Tennessee, Georgia, Alabama, Louisiana, and Texas	637,063	1,183,977	1,285	1,822,325	325,293	848,857	1,275	1,175,425
Ohio	4,024,662	2,726,219	4,170	6,755,051	2,842,700	2,592,778	2,905	5,458,383
Indiana and Illinois	1,475,424	3,444,900	20,600	4,940,984	871,210	2,525,450	13,989	3,410,649
Other States[a]	79,891	530,817	10,185	620,893	16,732	496,372	7,215	520,319
Total	9,545,706	21,599,931	155,237	31,300,874	6,220,846	17,174,684	117,500	3,513,030

[a] Figures for 1913 and 1914 include Canal Zone.

PRODUCTION OF ELECTRIC STEEL.[1]

The production of steel by the electric process in 1914 amounted to 24,009 tons, as compared with 30,180 tons in 1913, a decrease of 6,171 tons, or nearly 21 per cent. The following table gives the production of electric steel ingots and castings since 1909. In 1908 there were 55 tons of electric steel produced, but this tonnage was included with open-hearth steel for that year.

[1] American Iron and Steel Inst. Bur. Statistics.

Production of electrically manufactured steel in the United States, 1909 to 1914, in long tons.

Year.	Ingots.	Castings.	Total.
1909	13,456	306	13,762
1910	50,821	1,320	52,141
1911	27,227	1,878	29,105
1912	14,147	4,162	18,309
1913	23,973	9,207	30,180
1914	15,458	8,551	24,009

In the total production of electric steel in 1914 are included about 9,334 tons of steel ingots and castings which were treated with ferrovanadium, ferrotitanium, and ferrochrome, of which 9,004 tons were ingots and 330 tons were castings. In 1913 the production of similarly treated steel amounted to about 11,254 tons—10,821 tons of ingots and 433 tons of castings.

On December 31, 1914, the number of completed plants which were equipped for the manufacture of steel by the electric process was 22, as compared with 16 plants at the close of 1913, a gain of 6 plants. In addition 4 plants were being built on December 31, 1914—1 in New York, 2 in Pennsylvania, and 1 in Indiana.

PRODUCTION OF STEEL BY MISCELLANEOUS PROCESSES.

The production of steel in 1914 by various minor processes amounted to 3,622 tons, against 3,831 tons in 1913. The production in 1914 consisted of 312 tons of ingots and 3,310 tons of direct castings. Included in the total are 10 tons of alloy-treated steel castings. In 1914 there were 5 plants making steel by cementation and other minor processes, as follows: Connecticut, 1; Pennsylvania, 1; Ohio, 1; and Indiana, 2; in 1913 there were 5 plants. The following table gives the production of miscellaneous steel ingots and castings since 1898:

Production of miscellaneous steel ingots and castings in the United States, 1898 to 1914, in long tons.

Year.	Ingots.	Castings.	Total.	Year.	Ingots.	Castings.	Total.
1898	225	3,576	3,801	1907	989	13,086	14,075
1899	1,030	3,944	4,974	1908	519	5,613	6,132
1900	6	4,856	4,862	1909	786	8,399	9,185
1901	214	5,257	5,471	1910	.....	3,194	3,194
1902	2,833	5,553	8,386	1911	417	2,427	2,844
1903	3,395	6,409	9,804	1912	542	2,311	2,853
1904	2,172	7,018	9,190	1913	587	3,244	3,831
1905	2,572	6,391	8,963	1914	312	3,310	3,622
1906	3,510	10,870	14,380				

TOTAL PRODUCTION OF STEEL.

The statistics of the production of the various kinds of steel, so far as has been recorded, are given in the following table:

Production of steel in the United States, 1810–1914, in long tons.

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1810			917		917
1860			11,838		11,838
1863			8,075		8,075
1864			9,258		9,258
1865			13,627		13,627
1866			16,940		16,940
1867	2,679		16,964		19,643
1868	7,589		19,197		26,786
1869	10,714	893	19,643		31,250
1870	37,500	1,339	29,911		68,750
1871	40,179	1,785	31,250		73,214
1872	107,236	2,679	26,125	6,911	142,954
1873	152,368	3,125	31,059	12,244	198,796
1874	171,369	6,250	32,436	5,672	215,727
1875	335,283	8,080	35,180	11,256	389,799
1876	469,639	19,187	35,163	9,202	533,191
1877	500,524	22,349	36,098	10,647	569,618
1878	653,773	32,255	38,309	7,640	731,977
1879	829,439	50,259	50,696	4,879	935,273
1880	1,074,262	100,851	64,664	7,558	1,247,335
1881	1,374,247	131,202	80,145	2,720	1,588,314
1882	1,514,687	143,341	75,973	2,691	1,736,692
1883	1,477,345	119,356	71,835	4,909	1,673,535
1884	1,375,531	117,515	53,270	4,563	1,550,879
1885	1,519,430	133,376	57,599	1,515	1,711,920
1886	2,269,190	218,973	71,973	2,367	2,562,503
1887	2,936,033	322,069	75,375	5,554	3,339,071
1888	2,511,161	314,318	70,279	3,682	2,899,440
1889	2,930,204	374,543	75,865	5,120	3,385,732
1890	3,688,871	513,232	71,175	3,793	4,277,071
1891	3,247,417	579,753	72,586	4,484	3,904,240
1892	4,168,435	669,889	84,709	4,548	4,927,581
1893	3,215,686	737,890	63,613	2,806	4,019,995
1894	3,571,313	784,936	51,702	4,081	4,412,032
1895	4,909,128	1,137,182	67,666	858	6,114,834
1896	3,919,906	1,298,700	60,689	2,394	5,281,689
1897	5,475,315	1,608,671	69,959	3,012	7,156,957
1898	6,609,017	2,230,292	89,747	3,801	8,932,857
1899	7,586,354	2,947,316	101,213	4,974	10,639,857
1900	6,684,770	3,398,135	100,562	4,862	10,188,329
1901	8,713,302	4,656,309	98,513	5,471	13,473,595
1902	9,138,363	5,687,729	112,772	8,386	14,947,250
1903	8,592,829	5,829,911	102,434	9,804	14,534,978
1904	7,859,140	5,908,166	83,391	9,150	13,859,887
1905	10,941,375	8,971,376	102,233	8,963	20,023,947
1906	12,275,830	10,980,413	127,513	14,380	23,398,136
1907	11,667,549	11,549,736	131,234	14,075	23,362,594
1908	6,116,755	7,836,729	63,631	6,132	14,023,247
1909	9,330,783	14,493,936	107,355	22,947	23,955,021
1910	9,412,772	16,504,509	122,303	55,335	26,094,919
1911	7,947,854	15,598,650	97,653	31,949	23,676,106
1912	10,327,901	20,780,723	121,517	21,162	31,251,303
1913	9,545,706	21,599,931	121,226	34,011	31,300,874
1914	6,220,846	17,174,684	89,869	27,631	23,513,030

COPPER.

By B. S. Butler.

INTRODUCTION.

In the production of metallic copper suitable for commercial purposes at least three distinct processes are usually required, namely, mining, smelting, and refining. The Lake Superior native copper district is the only important producer where these three processes are not entirely distinct. It is possible, therefore, to ascertain the copper output of the country by collecting statistics from the mines, from the smelters, and from the refineries, and each of these sets of figures has its advantages. The mine figures have the advantage of giving the most accurate distribution of the production but are less accurate in total quantity of copper recovered; the smelter figures permit of reasonably accurate distribution and also furnish the actual recovery of copper from the ores treated during the year; the refinery figures furnish the best measure of the copper made available for commercial uses during the year, but at this stage of manufacture the accurate distribution to the State of origin, or even the separation of copper derived from domestic and from foreign sources, is uncertain.

Statistics for 1914 showing the production of each of these stages of manufacture have been collected by the United States Geological Survey, and are presented in the following report.

As the same material passes through the three processes of manufacture at successive periods, usually requiring two to three months from the time it is taken from the mine before it reaches the stage of refined copper, the year's production as recorded for the different stages does not represent the same materials—that is, the refinery production for the calendar year 1914 represents the mine production from about October 1, 1913, to October 1, 1914. The three sets of figures representing the successive stages of manufacture do not, therefore, necessarily agree, although they should not differ greatly if the condition of the industry is normal. The mine figures and the smelter figures will differ by the difference in the quantity of ore, matte, and other materials in stock at the beginning and at the end of the year and by the difference in the quantity of copper reported by the mines and that recovered by the smelters. This difference is due to the fact that considerable copper is recovered from sulphur, lead, zinc, and siliceous ores carrying values in copper so low that the mines do not receive pay for and frequently do not report the copper content of the ore, although it is eventually recovered by the smelters. The smelter and refinery figures will differ by the increase or decrease in stock of blister and other unrefined forms of copper at the beginning and at the end of the year and by the loss in refining.

As the smelter production permits reasonably accurate distribution as to the source by States and also gives the actual output of

copper, it is adopted in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district.

SUMMARY OF STATISTICS.

The following statistical statement summarizes the copper industry in the United States in 1911, 1912, 1913, and 1914:

Summary of statistics of the copper industry in the United States in 1911, 1912, 1913, and 1914.

	1911	1912	1913	1914
Production of copper:				
Smelter output.....pounds..	1,097,232,749	1,243,268,720	1,224,484,098	1,150,137,192
Mine production.....do....	1,114,764,197	1,249,094,891	1,235,569,727	1,148,431,437
Refinery production of new copper—				
Electrolytic.....do....	823,507,764	914,935,371	1,022,497,601	991,573,073
Lake.....do....	218,185,236	231,112,228	155,715,286	158,009,748
Casting and pig.....do....	59,577,803	57,629,296	58,611,026	60,840,368
Total domestic.....do....	1,101,270,803	1,203,676,895	1,236,823,913	1,210,423,189
Total domestic and foreign.....do....	1,433,875,026	1,568,104,478	1,615,067,782	1,533,781,394
Total new and old copper.....do....	1,648,000,000	1,843,000,000	1,888,000,000	1,790,000,000
Total ore produced.....short tons..	29,994,942	35,671,028	36,361,101	35,187,118
Copper ore produced.....do....	29,988,235	35,656,414	36,336,682	35,175,541
Average yield of copper.....per cent..	1.825	1.71	1.67	1.60
Imports.....pounds..	334,607,538	410,240,295	408,778,954	306,350,827
Exports.....do....	786,553,208	775,000,658	926,241,092	840,080,922
Consumption:				
Total new copper.....do....	681,753,279	775,978,332	812,068,639	711,624,158
Total new and old copper.....do....	895,900,000	1,051,000,000	1,085,000,000	968,000,000
World's production.....do....	1,954,957,560	2,259,101,580	2,198,732,130	.....
Value of production in the United States.....	$137,154,092	$205,139,338	$189,795,035	$152,968,246

Production of copper in the United States in 1913 and 1914.

[Smelter output, in pounds fine.]

	1913	1914		1913	1914
Alaska	23,423,070	24,985,847	Pennsylvania	245,337	422,741
Arizona	404,278,809	382,449,922	Philippine Islands	22	.....
California	32,492,265	29,784,173	South Dakota	4,549	.....
Colorado	9,052,104	7,316,066	Tennessee	19,489,654	18,661,112
Idaho	8,711,490	5,875,205	Texas	39,008	34,272
Maryland	.....	12,248	Utah	148,057,450	160,589,660
Michigan	155,715,286	158,009,748	Vermont	5,771	.....
Missouri	576,204	53,519	Virginia	46,961	17,753
Montana	285,719,918	236,805,845	Washington	732,742	683,602
Nevada	85,209,536	60,122,904	Wisconsin	.....	10,098
New Mexico	50,196,881	64,204,703	Wyoming	362,235	17,082
North Carolina	180	19,712	Undistributed	46,803	55,381
Oklahoma	11	.....			
Oregon	77,812	5,599	Total	1,224,484,098	1,150,137,192

GENERAL CONDITION OF THE INDUSTRY.

The smelter production of copper in 1914 showed a considerable decrease from that of 1913. This decrease was due to the unfavorable market conditions brought about by the European war and prevailing during the last five months of the year. During the first seven months of the year production was at a considerably higher rate than for the year 1913, but early in August, following the outbreak of the war, most of the large producers curtailed their output from 30 to 50 per cent, and many small producers shut down their plants.

The refinery production, like that of the smelters, showed a reduction from that of 1913, due to the same causes.

Regardless of the unfavorable conditions the average cost of producing copper in 1914 was doubtless considerably less than in 1913. The average cost per pound in 1914 of producing electrolytic and casting copper, as compiled from the annual reports of companies giving this item, was 8.62 cents, as compared with 9.49 cents in 1913 and with 8.74 cents in 1912. This cost for electrolytic and casting copper is probably somewhat below the average cost of the entire output, but doubtless represents the general trend of costs for the three years. The average cost per pound for Lake copper, as compiled from the reports of companies giving this item, was 10.94 cents in 1914, as compared with 13.44 cents in 1913 and with 10.28 cents in 1912. The cost figures for the year are somewhat surprising, in view of the marked curtailment of output for a part of the year, which might be supposed to raise the cost.

The demonstration of this elasticity and ability to meet varying conditions should be a source of satisfaction to all interested in the copper industry.

The ability to produce at reduced cost under the conditions may be attributed to several causes. The treatment of reduced outputs, especially of concentrating ore, resulted in a higher recovery of copper. By some operators a higher grade of ore was treated during the period of curtailment, though this was by no means universal. The average copper recovered from ore treated in 1914 was 1.60 per cent as compared with 1.67 per cent in 1913. The cost of labor during the period of curtailment was materially reduced by decreasing wages, and there can be little doubt that there was a notable increase in the efficiency of labor during this period. Development and construction work was generally discontinued during the latter part of the year, and these items doubtless account in no small part for the results.

The average selling price of electrolytic copper, as compiled from the reports of companies giving that item, was 13.4 cents in 1914, and that of Lake copper was also 13.4. This was not quite 2 cents a pound lower than the selling price for 1913, and it is evident that the profits of the industry were considerably less in 1914 than in 1913, regardless of the lowering of the cost price.

As for some years past, much attention was given during 1914 to improvement in metallurgical practice. Within the last few years many of the smelting plants of the country have been remodeled or entirely new plants have been built. A notable feature of this reconstruction has been the increase in reverberatory furnace capacity, with corresponding decrease in blast-furnace capacity. Perhaps the most important metallurgical change introduced in 1914 was the installation of flotation plants in concentrating mills. These plants have been most successfully employed, both in the cleaning of concentrates produced by the usual wet methods, and in the treatment of certain of the mill products, in which products the losses by the methods previously in use were heavy. The use of the flotation process in the treatment of copper ores will probably be largely increased in the next few years. The development of leaching processes, which has received much attention for some time, was

actively carried on during the year by several companies, and plants are now in process of construction that will employ this method both for the treatment of low-grade oxidized ores hitherto unavailable and for the recovery of additional copper from the material treated by other processes that has hitherto been discarded as tailings.

Both domestic consumption and export of copper showed a marked decrease, and in spite of the decreased output there was a considerable increase in the stock of refined copper at the close of 1914, as compared with 1913.

The outlook for the immediate future in the industry is so closely dependent on conditions that can not be foreseen, that any prediction is of little value. Important new producers will enter the field in 1915, notably the Inspiration Consolidated Co., of Arizona, and the White Pines Co., of the Lake district. Many of the older producers are prepared to make larger production than ever before, and if there is demand for the metal the output can be largely increased. During the first half of 1915 there was a steady improvement in market conditions and in production, and by the close of the half-year period production was probably about normal.

At the outbreak of the war the copper producers, with promptness and keen foresight, curtailed production to meet changed conditions, and it is reasonable to expect that the future production will be largely controlled by demands for the metal.

In July, 1914, the Copper Producers' Association discontinued the publication of monthly statistics of production, domestic deliveries, export, and stocks of marketable copper, and later the association disorganized. This association was formed in 1909 and since that time had published monthly statistics. It is hoped that some new organization may be formed, by which not only the condition of the producing but also that of the consuming end of the industry shall be reported at frequent intervals, so that there shall be no undue advantage but rather a mutual helpfulness in regulating the industry to the best advantage of all concerned.

PRODUCTION.

SMELTER AND MINE PRODUCTION.

GENERAL STATEMENT.

The production of copper in 1914 by smelters from copper-bearing materials from the United States was 1,150,137,192 pounds, valued at $152,968,246,[1] as compared with 1,224,484,098 pounds, valued at $189,795,035, in 1913, and with 1,243,268,720 pounds, valued at $205,139,338, in 1912. The production for 1914 decreased from that of 1913 by 74,346,906 pounds, or about 6.1 per cent, in quantity, and by $36,826,789 in value.

The yearly production of copper in the United States from 1845 to 1914, inclusive, together with the actual and relative changes from each preceding year, is shown in the following table:

[1] For discussion of prices see section on prices on a subsequent page.

Magnitude and growth of production of copper in the United States from 1845 to 1914, inclusive.

Year.	Production.	Increase.		Average annual increase, by decades.	
	Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
1845	224,000				
1846	336,000	112,000	50.0		
1847	672,000	336,000	100.0	246,400	50.0
1848	1,120,000	448,000	67.0		
1849	1,568,000	448,000	40.0		
1850	1,456,000	a 112,000	a 7.1		
1851	2,016,000	560,000	38.4		
1852	2,464,000	448,000	22.2		
1853	4,480,000	2,016,000	81.8		
1854	5,040,000	560,000	12.5		
1855	6,720,000	1,680,000	33.3	1,467,200	28.5
1856	8,960,000	2,240,000	33.3		
1857	10,752,000	1,792,000	20.0		
1858	12,320,000	1,568,000	14.6		
1859	14,112,000	1,792,000	14.5		
1860	16,128,000	2,016,000	14.3		
1861	16,800,000	672,000	4.1		
1862	21,160,000	4,360,000	26.0		
1863	19,040,000	a 2,120,000	a 10.0		
1864	17,920,000	a 1,120,000	a 5.9		
1865	19,040,000	1,120,000	6.3	1,209,600	6.2
1866	19,936,000	896,000	4.7		
1867	22,400,000	2,464,000	12.3		
1868	25,984,000	3,584,000	16.0		
1869	28,000,000	2,016,000	7.7		
1870	28,224,000	224,000	.8		
1871	29,120,000	896,000	3.2		
1872	28,000,000	a 1,120,000	a 3.8		
1873	34,720,000	6,720,000	24.0		
1874	39,200,000	4,480,000	12.9		
1875	40,320,000	1,120,000	2.9	3,225,600	8.2
1876	42,560,000	2,240,000	5.6		
1877	47,040,000	4,480,000	10.0		
1878	48,160,000	1,120,000	2.4		
1879	51,520,000	3,360,000	7.0		
1880	60,480,000	8,960,000	17.4		
1881	71,680,000	11,200,000	18.5		
1882	90,646,232	18,966,232	26.5		
1883	115,526,053	24,879,821	27.4		
1884	144,946,653	29,420,600	25.5		
1885	165,875,766	20,929,113	14.4	19,928,309	16.2
1886	156,735,381	a 9,140,385	a 5.5		
1887	180,920,524	24,185,143	15.4		
1888	226,361,466	45,440,942	25.0		
1889	226,775,962	414,496	.2		
1890	259,763,092	32,987,130	14.5		
1891	284,121,764	24,358,672	9.4		
1892	344,998,679	60,876,915	21.4		
1893	329,354,398	a 15,644,281	a 4.5		
1894	354,188,374	24,833,976	7.5		
1895	380,613,404	26,425,030	7.4	34,635,407	9.4
1896	460,061,430	79,448,026	20.0		
1897	494,078,274	34,016,844	7.4		
1898	526,512,987	32,434,713	6.6		
1899	568,666,921	42,153,934	8.0		
1900	606,117,166	37,450,245	6.6		
1901	602,072,519	a 4,044,647	a .7		
1902	659,508,644	57,436,125	9.5		
1903	698,044,517	38,535,873	5.8		
1904	812,537,267	114,492,750	16.4		
1905	888,784,267	76,247,000	11.0	47,404,234	6.3
1906	917,805,682	29,021,415	3.3		
1907	868,996,491	a 48,809,191	a 5.3		
1908	942,570,721	73,574,230	8.5		
1909	1,092,951,624	150,380,903	15.9		
1910	1,080,159,509	a 12,792,115	a 1.2		
1911	1,097,232,749	17,073,240	1.6		
1912	1,243,268,720	146,035,971	13.3		
1913	1,224,484,098	a 18,784,622	1.5		
1914	1,150,137,192	a 74,346,906	6.1		
Total	20,007,614,102				

a Decrease.

The figures, except for 1914, are taken from the previous volumes of Mineral Resources of the United States. Statistics from 1882 to 1914, inclusive, are based on the returns to the United States Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the Survey from the best sources available. Reliable figures for years previous to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and, since 1880 when Arizona and Montana became important producers, a very rapid growth.

Only seven times since 1880 has the annual production shown a decrease from that of the preceding year and in every instance the decrease has been slight and has been more than recovered in the following year. The years showing a decrease are 1886, 1893, 1901, 1907, 1910, 1913, and 1914. In several other years the increase has been slight. In most years in which there has been a decrease it may be attributed to a general condition of financial and business depression which has resulted in a decrease in the demand for copper and other materials necessary to the expansion of industries. In three years a slight decrease appears to have been due to the fact that the producing capacity of the country had been increased out of proportion to the demand for domestic consumption and export, and a temporary curtailment in production became necessary to permit the absorption of accumulated stocks. This, coupled with attempts at artificial control of prices, appears to have been the case in 1886 and also in 1901, and the decrease in production in 1910 may be attributed to a similar cause. The large increase in 1912 which, with one exception, that of 1909, was the largest in the histroy of the industry, was due to the output from mines that reached the producing stage during 1912 or had previously made but relatively small production.

The decrease in 1913 was more than equaled by the falling off in Michigan due to labor troubles. The decrease in 1914 can be attributed entirely to the European war. Production during the first seven months was on an increased basis, but the curtailment during the last five months resulted in a net decrease.

The mines and metallurgical plants are in a position to make an increased production in 1915. This, however, is contingent on the demand for the metal. During the first half of 1915 there has been a rather steady increase in consumption. The future demands are dependent in a considerable measure on the conditions in Europe, and any prophecy as to the future consumption in European countries seems futile.

SMELTER RETURNS.

The figures of smelter production for 1914 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries to secure the accurate distribution of the output sincere thanks are extended. The following list gives the names of the

owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1914. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

Copper smelting plants that treated materials from the United States in 1914.

Location.	Company.	Final copper product.
UNITED STATES.		
Arizona:		
Clifton	Arizona Copper Co	Blister.
Do	Shannon Copper Co	Do.
Douglas	Calumet & Arizona Mining Co	Do.
Do	Copper Queen Consolidated Mining Co	Do.
Globe	Old Dominion Copper Mining & Smelting Co.	Do.
Hayden	American Smelting & Refining Co	Do.
Humboldt	Consolidated Arizona Smelting Co	Do.
Jerome	United Verde Copper Co	Do.
Morenci	Detroit Copper Mining Co	Do.
California:		
Campo Seco	Penn Mining Co	Do.
Kennett	Mammoth Copper Mining Co	Do.
Martinez	Mountain Copper Co	Do.
Colorado:		
Ouray	Brown Mountain Smelting Co	Matte.
Do	Wanakah Mining Co	Do.
Salida	Ohio & Colorado Smelting & Refining Co	Do.
Maryland: Baltimore	Baltimore Copper Smelting & Rolling Co	Electrolytic.
Michigan:		
Hancock	Lake Superior Smelting Co	Anodes and Lake.
Do	Quincy Mining Co	Do.
Houghton	Michigan Smelting Co	Do.
Hubbell	Calumet & Hecla Mining Co	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co	Blister.
Butte	East Butte Copper Mining Co	Do.
Great Falls	Anaconda Copper Mining Co	Blister and electrolytic.
Nebraska: Omaha	American Smelting & Refining Co	Blister.
Nevada:		
Wabuska	Mason Valley Mines Co	Matte.
McGill	Nevada Consolidated Copper Co	Blister.
New Jersey: [a]		
Chrome	United States Metals Refining Co	Electrolytic and casting.
Maurer	American Smelting & Refining Co	Electrolytic.
Newark	Balbach Smelting & Refining Co	Electrolytic and casting.
Perth Amboy	Raritan Copper Works	Electrolytic.
New Mexico: San Pedro	Santa Fe Gold & Copper Mining Co	Matte.
New York:		
Black Rock	Buffalo Smelting Works [b]	Lake and electrolytic.
Laurel Hill	Nichols Copper Co	Electrolytic and casting.
Tennessee:		
Copperhill	Tennessee Copper Co	Blister.
Isabella	Ducktown Sulphur, Copper & Iron Co. (Ltd.)	Matte.
Texas: El Paso	American Smelting & Refining Co	Blister.
Utah:		
Garfield	Garfield Smelting Co	Do.
International	International Smelting & Refining Co	Do.
Virginia: West Norfolk	Norfolk Smelting Co	Matte.
Washington: Tacoma	Tacoma Smelting Co	Blister and electrolytic.
CANADA.		
British Columbia:		
Grand Forks	Granby Consolidated Mining, Smelting & Power Co.	Blister.
Greenwood	British Columbia Copper Co. (Ltd.)	Do.
Trail	Consolidated Mining & Smelting Co. of Canada.	Matte.
MEXICO.		
Aguas Calientes:		
Aguas Calientes	American Smelting & Refining Co	Blister.
Cananea	Cananea Consolidated Copper Co	Do.

[a] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister from material solely of foreign origin.
[b] Operations at this plant discontinued in 1914.

During the year 43 copper smelting and refining plants treated material from the United States. Of these, 38 were domestic plants and 5 were foreign—3 located in British Columbia and 2 in Mexico.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. As to blister copper, the figures represent the fine copper content. Some casting copper is produced direct from ore and matte, and this is included in the smelter production.

MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1914. These mines reported 1,148,431,437 pounds of copper, or 1,705,755 pounds less than the smelters. The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. In the case of mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion there is likely to be considerable discrepancy, as the mines may report a considerable quantity that has not reached the stage of blister by the close of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or at the close of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. A number of operators report the copper in their ores and concentrates on the basis of assay content, in which case it exceeds the smelter recovery from the same material by the quantity lost in smelting. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for, and, consequently, is not always reported by the mines.

The following table shows the output of copper from domestic ores for the last nine years as reported by mines, smelters, and refineries:

Production of copper from domestic ores as reported by the mines, the smelters, and the refineries, 1906–1914, in pounds.

Year.	Mine.	Smelter.	Refinery.
1906	916,971,387	917,805,682	887,682,387
1907	847,151,015	868,996,491	784,271,427
1908	956,840,578	942,570,721	919,111,414
1909	1,126,521,126	1,092,951,624	1,065,564,921
1910	1,088,237,432	1,080,159,509	1,071,894,876
1911	1,114,764,197	1,097,232,749	1,101,270,803
1912	1,249,094,891	1,243,268,720	1,203,676,895
1913	1,235,569,727	1,224,484,098	1,236,823,913
1914	1,148,431,437	1,150,137,192	1,210,423,189
Total	9,683,581,790	9,617,606,786	9,480,719,825

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

It appears that although theoretically the output reported by the mines should be considerably in excess of that reported by the smelters, this difference in the last nine years has been nearly balanced by the copper recovered from lead, zinc, gold, silver, and sulphur ores which carry copper values so low that they are not paid for and consequently have not usually been reported by the mines.

PRODUCTION BY STATES.

Twenty-two States and Territories contributed to the production of copper in 1914. The following table shows the mine and the smelter output of individual States for 1913 and 1914.

According to smelter returns, the four leading States, Arizona, Montana, Utah, and Michigan, produced 82 per cent of the total output of 1914; the same States produced 81.16 per cent of the output in 1913; and the eight leading States, including Nevada, Alaska, California, and New Mexico, produced 97.11 per cent of the total output in 1914.

Production of copper by smelter returns in 1913 and 1914, compared with mine returns for same years, by States, in pounds.

State.	Production.					
	1914				1913	
	Rank.	Percentage of total.	Smelter returns.	Mine returns.	Smelter returns.	Mine returns.
Alaska	8	2.17	24,985,847	21,450,628	23,423,070	21,659,958
Arizona	1	33.25	382,449,922	393,017,400	404,278,809	407,923,402
California	7	2.58	29,784,173	30,507,692	32,492,265	34,575,007
Colorado	10	.64	7,316,066	6,639,173	9,052,104	7,727,826
Idaho	11	.51	5,875,205	6,445,187	8,711,490	9,592,966
Maryland	20	.....	12,248	(a)	.....	(a)
Michigan	4	13.73	158,009,748	164,344,058	155,715,286	135,853,409
Missouri	15	.....	53,519	44,463	576,204	576,204
Montana	2	20.59	236,805,845	233,229,640	285,719,918	287,828,699
Nevada	6	5.23	60,122,904	60,986,450	85,209,536	90,693,751
New Mexico	5	5.58	64,204,703	59,307,925	50,196,881	56,308,706
North Carolina	17	.....	19,712	20,434	180	.....
Oklahoma	.....	.....	.....	.....	11	.....
Oregon	22	.....	5,599	39,248	77,812	43,330
Pennsylvania	13	.04	422,741	a 658,264	245,337	a 503,792
Philippine Islands	.....	.....	.....	.....	22	.....
South Dakota	.....	.....	.....	.....	4,549	1,793
Tennessee	9	1.62	18,661,112	18,737,656	19,489,654	19,390,750
Texas	16	.....	34,272	23,760	39,008	34,665
Utah	3	13.96	160,589,660	152,034,002	148,057,450	161,445,962
Vermont	.....	.....	.....	.....	5,771	13,900
Virginia	18	.....	17,753	139,008	46,961	56,287
Washington	12	.06	683,602	778,728	732,742	954,081
Wisconsin	21	.....	10,098	10,300	.....	.....
Wyoming	19	.....	17,082	17,421	362,235	385,239
Unapportioned	14	.....	55,381	.....	46,803	.....
Total	.....	.....	1,150,137,192	1,148,431,437	1,224,484,098	1,235,569,727

a Pennsylvania and Maryland combined.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, although the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced.

The following table shows the production from 1905 to 1914 for each State for which separate statistics are available.

In the report for 1910 the annual production by States since 1845 is given. This report can be procured on application to the Director of the United States Geological Survey, Washington, D. C.

Production of copper in the United States, 1905–1914, by States, in pounds.

State.	1905	1906	1907	1908	1909
Alaska	4,900,866	8,685,646	7,034,763	4,438,836	4,057,142
Arizona	226,854,461	262,566,103	256,778,437	289,523,267	291,110,298
California	16,697,489	28,153,202	33,696,602	39,643,835	53,568,708
Colorado	9,404,830	7,427,253	13,998,496	13,943,878	11,485,631
Idaho	7,321,585	8,578,046	9,707,299	7,256,086	7,096,132
Michigan	230,287,992	229,695,730	219,131,503	222,289,584	227,035,923
Montana	314,750,582	294,701,252	224,263,789	252,503,651	314,858,291
New Mexico	5,334,192	7,099,842	10,140,140	4,991,351	5,031,136
Nevada	413,292	1,090,635	1,998,164	12,241,372	53,849,281
Oregon	846,615	545,859	518,694	271,191	245,463
South Dakota	38	.....	.....	5,471	41,988
Utah	54,083,506	50,329,119	66,418,370	71,370,370	101,241,114
Washington	223,328	290,823	122,263	162,201	120,611
Wyoming	2,530,531	106,177	3,026,004	2,416,197	433,672
Eastern States	15,134,960	.....	.....	.....	.....
Southern States		.....	.....	.....	.....
Middle States		.....	.....	.....	.....
Eastern States and unapportioned	.....	18,535,995	22,161,967	21,513,431	22,806,294
Total	888,784,267	917,805,682	868,996,491	942,570,721	1,092,951,624

State.	1910	1911	1912	1913	1914
Alaska	4,311,026	22,314,889	31,926,209	23,423,070	24,985,847
Arizona	297,250,538	303,202,532	359,322,096	404,278,809	382,449,922
California	45,760,200	35,835,651	31,516,471	32,492,265	29,784,173
Colorado	9,307,497	9,791,861	7,963,520	9,052,104	7,316,066
Idaho	6,877,515	4,514,116	7,182,185	8,711,490	5,875,205
Michigan	221,462,984	218,185,236	231,112,228	155,715,286	158,009,748
Montana	283,078,473	271,814,491	308,770,826	285,719,918	236,805,845
New Mexico	3,784,609	2,860,400	29,170,400	50,196,881	64,204,703
Nevada	64,494,640	65,561,015	83,413,900	85,209,536	60,122,904
Oregon	22,022	125,943	311,860	77,812	5,599
South Dakota	43	1,607	23,657	4,549	.....
Utah	125,185,455	142,340,215	132,150,052	148,057,450	160,589,660
Washington	65,021	195,503	1,069,938	732,742	683,602
Wyoming	217,127	130,499	25,080	362,235	17,082
Eastern States and unapportioned	18,342,359	20,358,791	19,310,298	20,449,951	19,286,836
Total	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,098	1,150,137,192

Total production of copper, by States, 1845–1914, and percentage and rank of each State.

	Quantity.	Percentage.	Rank.
	Pounds.		
Alaska	139,461,470	0.70	10
Arizona	4,649,437,627	23.24	3
California	574,763,517	2.87	5
Colorado	237,875,614	1.19	9
Idaho	80,840,680	.40	11
Michigan	5,519,442,640	28.59	2
Montana	6,429,550,473	32.14	1
New Mexico	238,755,547	1.19	8
Nevada	432,246,452	2.16	6
Oregon	2,970,998	.01	15
South Dakota	5,283,626	.03	13
Utah	1,241,911,837	6.21	4
Washington	4,659,566	.02	14
Wyoming	26,378,296	.13	12
Eastern States and unapportioned	424,035,759	2.12	7
Total	20,007,614,102	100.00	.....

The totals in the preceding table show the copper output of each important copper-producing State, except those on the Atlantic coast, since the beginning of the industry. Some copper was produced in New Mexico in the early years of the last century, but the exact quantity is not known. It was not large as measured by present production of the metal. A little copper was also produced in Michigan prior to 1845, but it was not sufficient in quantity to be of importance. Considerable copper was produced in the Eastern States prior to 1845.

Under "Eastern States and unapportioned" is included some copper classed as "lead desilverizers" in the earlier reports of the Survey. This should properly be credited to some of the Western States. The output of the Central States, except Michigan, is also included under this head. Statistics for the individual Eastern States have not been compiled, but it may be stated that approximately 287,203,000 pounds has been derived from Tennessee. Of the remainder, Vermont and Virginia have made the largest contributions, and some copper has been produced by practically all of the Appalachian States.

It will be noted that Montana, Michigan, and Arizona stand out as the three great copper-producing States. Montana ranks first, with nearly one-third of the entire output of the country; Michigan ranks second, with more than 28 per cent; and Arizona ranks third, with more than one-fifth. Utah, ranking next in order, has produced about one-twentieth of the total output. The three leading States have produced 83 per cent of the entire production.

It will be noted by reference to the table showing the output for 1914 that these three States still maintain their preeminence, producing 81 per cent of the total output in 1908, 76 per cent in 1909, 74 per cent in 1910, 72 per cent in 1911 and 1912, 69 per cent in 1913, and 68 per cent in 1914.

In the following table is given the output of blister copper of the leading districts of the country in 1914:

Production of blister copper in the principal districts in 1914, in pounds.

District or region.	State.	Approximate smelter output.	Percentage of total production.	Rank.
Butte	Montana	235,700,000	20.49	1
Lake Superior	Michigan	158,009,000	13.74	2
Bisbee	Arizona	150,960,000	13.13	3
Bingham	Utah	150,000,000	13.04	4
Globe	Arizona	72,800,000	6.32	5
Morenci-Metcalf	do	66,000,000	5.74	6
Mineral Creek (Ray)	do	57,000,000	4.96	7
Santa Rita	New Mexico	54,000,000	4.70	8
Ely	Nevada	50,542,000	4.39	9
Jerome	Arizona	30,000,000	2.61	10
Shasta County	California	25,100,000	2.18	11
Alaska (all districts)		24,985,000	2.17	12
Ducktown	Tennessee	18,661,000	1.62	13
Yerington	Nevada	7,480,000	.65	14
Tintic	Utah	6,000,000	.52	15
Calaveras County	California	4,400,000	.38	16
Big Bug	Arizona	3,694,000	.32	17
Coeur d'Alene	Idaho	3,460,000	.30	18
Lordsburg	New Mexico	2,614,000	.23	19
Leadville	Colorado	2,382,000	.21	20
Pioneer	Arizona	2,213,000	.19	21
Cochise	do	2,145,000	.19	22
Alder Creek	Idaho	2,100,000	.18	23
Palmetto	Arizona	1,726,000	.15	24
San Juan-Ouray	Colorado	1,680,000	.15	25
Courtland (Turquoise)	Arizona	1,586,000	.14	26
Beaver County	Utah	1,511,000	.13	27
Ophir	do	1,255,000	.11	28
Uinta Summit (Park City)	do	1,167,000	.11	29
Total		1,139,170,000	99.05	
All others		10,967,000	.95	
Grand total		1,150,137,000	100.00	

As shown in this table, 29 districts in 1914 each produced 1,000,000 or more pounds of blister copper.

The following table shows the output of the principal copper-producing districts of the United States from the beginning of production to the close of 1914. For the later years the statistics are compiled from reports furnished to the United States Geological Survey by the producing companies. For the earlier years the figures are taken mainly from reports on the several districts by members of the Survey.

Total production of blister copper of the principal districts to the close of 1914, in pounds, and percentage of total and rank of each.

District.	State.	Production began—	Quantity.	Percentage of total production.	Rank.
Butte	Montana	1868	6,413,500,000	32.05	1
Lake Superior	Michigan	1845	5,519,004,000	27.58	2
Bisbee	Arizona	1880	1,861,260,000	9.30	3
Morenci-Metcalf	do	1873	1,170,200,000	5.85	4
Bingham	Utah	1896	984,500,000	4.93	5
Jerome	Arizona	1883	700,180,000	3.50	6
Globe	do	1881	584,700,000	2.92	7
Shasta County	California	1897	443,800,000	2.22	8
Ely	Nevada	1908	376,442,000	1.88	9
Ducktown	Tennessee	1850	287,205,000	1.43	10
Santa Rita	New Mexico	1800 (?)	233,911,000	1.17	11
Mineral Creek (Ray)	Arizona	.....	159,640,000	.80	12
Foothills Belt	California	1862	125,700,000	.63	13
Tintic	Utah	1880 (?)	119,150,000	.60	14
Total	.....	.....	18,979,192,000	94.86	.....
All others	.....	.....	1,028,422,000	5.14	.....
Grand total	.....	.....	20,007,614,000	100.00	.....

Fourteen districts situated in 8 States have each contributed in excess of 100,000,000 pounds to the copper output of the country. Five of these districts are in Arizona, 2 each in California and Utah, and 1 each in Montana, Michigan, Nevada, New Mexico, and Tennessee. Two districts stand out prominently. They are the Butte district, Mont., which has contributed nearly one-third of the output of the country, and the Lake Superior district, Mich., which has produced more than 28 per cent of the total output. Bisbee, ranking third, has yielded 9.30 per cent of the total production. The 14 districts have yielded 94.86 per cent of the total output of the United States since 1845.

It is noteworthy that not a single one of the leading copper districts of the United States, several of which have been active producers for a period of 30 years or more, has been worked out or showed a decrease in its ability to produce copper.

QUANTITY AND YIELD OF COPPER ORES.

COPPER-BEARING ORES PRODUCED IN 1914.

The following tables show the quantity and the yield in copper of the ore produced by the mines of the United States in 1914. The figures are taken from the mine reports referred to in the prefatory note, which form a part of the volume on Mineral Resources issued annually by the United States Geological Survey. The close agreement between the output as reported by the mines and the actual recovery of metal by the smelters indicates that the tenor of ores as reported by the mines is very close to the actual recovery of metal. The classification of some of the complex western ores is a difficult and more or less arbitrary matter. Under copper ores are classed those which contain 2½ per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is an important constituent.

Considerable copper was reported by the mines from ores mined primarily from other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for values in other metals. No attempt has been made to compile tables showing the quantity and yield of this group of copper-bearing ores, but together with old slags and other materials they have yielded a total of 20,274,252 pounds of copper.

Copper produced in 1914 from ores in which copper constitutes the principal value, by States.

State.	Copper ore.	Copper in ore.	Percentage.	Gold in ore.	Silver in ore.	Value in gold and silver per ton.
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
Alaska	153,605	21,450,628	6.64	8,283.30	283,355	$2.17
Arizona	7,508,020	391,020,335	2.60	50,842.80	2,604,371	.33
California	397,868	30,507,692	3.84	16,630.16	703,042	1.84
Colorado	12,196	1,330,056	5.45	3,243.88	173,845	13.38
Idaho	93,040	4,986,206	2.68	1,076.54	239,355	1.66
Michigan	9,269,413	164,344,058	.89		413,500	.02
Missouri	18	2,463	6.85		14	.43
Montana	4,346,034	231,019,109	2.66	25,422.61	8,015,694	1.14
Nevada	2,882,121	60,398,084	1.05	49,476.61	181,733	.39
New Mexico	2,005,024	58,878,888	1.47	11,352.45	292,266	.20
Oregon						
Pennsylvania and Maryland	252,823	658,264	.13			
Tennessee	653,621	18,737,656	1.44	299.63	97,402	.09
Texas	231	23,760	5.13		6,826	16.32
Utah	7,578,220	142,988,221	1.94	97,955.32	1,726,230	.39
Virginia	1,440	139,008	2.05	20.76	1,458	.86
Washington	21,752	746,297	1.71	220.93	90,574	2.51
Wisconsin	37	10,300	13.51		16	.47
Wyoming	78	17,421	11.54		79	.56
Total and average.	35,175,541	1,127,258,546	1.60	264,824.99	14,829,760	.39

Copper ores concentrated and smelted, concentrates produced, and copper produced from each class of ore in 1914, by States.

State.	Ore concentrated.				Ore smelted.		
	Quantity.	Concentrates produced.	Copper in concentrates.	Percentage of copper from ore.	Quantity.	Copper produced.	Percentage of copper from ore.
	Short tons.	*Short tons.*	*Pounds.*		*Short tons.*	*Pounds.*	
Alaska	58,968	8,144	8,515,713	7.22	94,637	12,934,915	6.83
Arizona [a]	5,329,245	440,161	158,932,432	1.49	2,135,614	231,103,784	5.41
California	(b)				397,868	30,507,692	3.84
Colorado					12,196	1,330,056	5.45
Idaho	68,494	5,031	2,228,382	1.63	24,546	2,757,824	5.62
Michigan	9,269,413	132,070	164,344,058	.89			
Missouri					18	2,463	6.85
Montana [c]	3,716,347	1,305,976	166,352,667	2.24	573,032	58,168,286	5.08
Nevada	2,735,415	445,223	50,366,650	.92	136,005	10,016,559	3.68
New Mexico	1,917,104	148,919	53,390,820	1.39	87,920	5,488,168	3.12
Pennsylvania and Maryland	252,768	7,659	646,016	.13	55	12,248	1.10
Tennessee					653,621	18,737,656	1.44
Texas					231	23,760	5.13
Utah	7,106,594	360,569	125,778,515	.88	471,626	17,209,706	1.82
Virginia					1,440	139,008	2.05
Washington	13,278	1,486	215,865	.81	8,474	530,432	3.13
Wisconsin					37	10,300	13.51
Wyoming					78	17,421	11.54
Total and average.	30,467,626	2,855,238	730,771,118	1.20	4,597,398	389,090,278	4.23

[a] Slag smelted and ore leached amounted to 43,161 tons, containing 984,119 pounds of copper.
[b] Small quantity of copper ore concentrated included under ore smelted.
[c] Ore leached, 56,655 tons; copper from ore leached, 1,281,374 pounds; copper from precipitates, 5,216,782 pounds.

Copper produced from copper-lead and copper-zinc ores in 1914, by States.

State.	Copper-lead and copper-zinc ores.	Copper in ore.	Percentage of copper.
	Short tons.	*Pounds.*	
Arizona	4,892	316,684	3.24
Colorado	1,192	97,672	4.11
Idaho			
Montana	168	22,215	6.61
Nevada	3,762	325,404	4.32
New Mexico	380	41,991	5.53
Texas			
Utah	1,183	101,794	4.18
Total and average	11,577	905,760	3.91

Copper derived from ore classed as copper-bearing ores (copper, copper-lead, and copper zinc ores), and total production of copper from all sources in 1914, by States.

State.	Ore treated.	Copper recovered.	Percentage of copper.	Copper from all sources, including old slags, smelter cleanings, and precipitates.
	Short tons.	*Pounds.*		*Pounds.*
Alaska	153,605	21,450,628	6.64	21,450,628
Arizona	7,512,912	391,337,019	2.60	[a] 393,017,400
California	397,868	30,507,692	3.84	30,507,692
Colorado	13,388	1,427,728	5.33	[b] 6,639,173
Idaho	93,040	4,986,206	2.68	6,445,187
Michigan	9,269,413	164,344,058	.89	164,344,058
Missouri	18	2,463	6.85	[c] 44,463
Montana	4,346,202	231,041,324	2.66	[d] 233,229,640
Nevada	2,885,883	60,723,488	1.05	60,986,450
New Mexico	2,005,404	58,920,979	1.47	59,307,925
North Carolina				[e] 20,434
Oregon				39,248
Pennsylvania and Maryland	252,823	658,264	.13	658,264
Tennessee	653,621	18,737,656	1.44	18,737,656
Texas	231	23,760	5.13	23,760
Utah	7,579,403	143,090,015	.94	[f] 152,034,002
Virginia	1,440	139,008	2.05	139,008
Washington	21,752	746,297	1.71	778,728
Wisconsin	37	10,300	13.51	10,300
Wyoming	78	10,300	13.51	17,421
Total and average	35,187,118	1,128,157,185	1.60	1,148,431,437

[a] Considerable copper was recovered from old slags and ores not classed as copper ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Mainly recovered in dressing lead ores.
[d] Considerable copper was recovered as precipitates from mine waters and from ores not classed as copper ores.
[e] From slag.
[f] A large quantity of copper was derived from ores classed as lead ores, lead-zinc ores, and siliceous ores.

Copper ores produced in the United States, 1906–1914, by years, in short tons, and average yield in copper, gold, and silver.

Year.	Copper ores.	Yield in copper.	Yield per ton in gold.	Yield per ton in silver.	Value per ton in gold and silver.
	Short tons.	*Per cent.*	*Ounces.*	*Ounces.*	
1906	18,000,000	2.50	0.0150	0.882	$0.856
1907	20,253,000	2.11	.0135	.609	.682
1908	22,290,886	2.07	.0104	.666	.560
1909	27,932,618	1.98	.0097	.655	.540
1910	28,497,238	1.88	.0093	.562	.495
1911	29,988,235	1.82	.0089	.555	.492
1912	35,656.414	1.71	.0073	.517	.468
1913	36,336,682	1.67	.0057	.502	.420
1914	35,175,541	1.60	.0075	.422	.39

Copper ores produced in the United States, 1906–1914, by years, classified as smelting and concentrating ores, in short tons, and average yield in copper from each.

Year.	Smelting ores.		Concentrating ores.	
	Quantity.	Yield in copper.	Quantity.	Yield in copper.
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*
1906	3,278,000	.....	14,722,000	.....
1907	3,957,500	4.05	16,295,500	1.41
1908	4,665,534	4.27	17,760,522	1.485
1909	5,267,707	4.15	22,664,911	1.47
1910	5,001,394	4.14	23,495,844	1.40
1911	4,355,650	4.66	25,632,585	1.34
1912	5,014,018	4.45	30,642,396	1.26
1913	5,290,310	4.22	31,046,372	1.22
1914	4,597,398	4.23	30,467,626	1.20

QUANTITY OF ORE.

The output of copper, copper-lead, and copper-zinc ores mined in 1914 was 35,187,118 tons, as compared with 36,361,101 tons in 1913. Of this output 35,175,541 tons were copper ores and 11,577 tons were copper-lead and copper-zinc ores, as compared with 36,336,682 tons of copper ores and 24,419 tons of copper-lead and copper-zinc ores in 1913. Of the 35,175,541 tons of copper ores, 4,597,398 tons were smelting ores and 30,467,626 tons were concentrating ores, as compared with 5,290,310 tons of smelting ores and 31,046,372 tons of concentrating ores in 1913.

In 1914 concentrating ores produced 2,855,238 tons of concentrates, the average concentration being 10.67 into 1, as compared with 10.23 into 1 in 1913 and with 11.14 into 1 in 1912. Exclusive of the ores and concentrates from Michigan, 21,198,213 tons of ore produced 2,723,168 tons of concentrates, or a concentration of about 7.8 into 1, as compared with 8.2 into 1 for 1913.

By reference to the tables showing the production of ores for the last nine years it appears that there has been an increase of about 100 per cent in the ore mined since 1906. The actual increase has been mainly in concentrating ores which have increased more than 100 per cent. Michigan with 9,269,413 tons, was the largest producer of copper ores in 1914, and was followed in order by Utah, Arizona, Montana, Nevada, New Mexico, Tennessee, and California. In the output of smelting ores the States were in the following order: Arizona, Tennessee, Montana, Utah, and California; in the output of concentrating ores Michigan was first, followed in order by Utah, Arizona, Montana, Nevada, and New Mexico.

YIELD IN COPPER.

The 35,187,118 tons of copper, copper-lead, and copper-zinc ores mined in 1914 contained 1,128,157,185 pounds of copper, or an average of 1.60 per cent, as compared with 1.67 per cent for 1913. If the Michigan output be excluded, the yield of the remaining copper ores was 1.86 per cent in 1914, as compared with 1.84 per cent in 1913 and with 2.06 per cent in 1912.

In 1914 a total of 35,175,541 tons of copper ores produced 1,127,258,546 pounds of copper, or an average yield of 1.60 per cent copper, and 11,577 tons of copper-lead and copper-zinc ores produced

905,760 pounds, or an average yield of 3.91 per cent copper. The 4,597,398 tons of smelting ore yielded 389,090,278 pounds of copper, or an average of 4.23 per cent, as compared with 4.22 per cent in 1913 and with 4.45 per cent in 1912.

The 30,467,626 tons of concentrating ore yielded 730,771,118 pounds of copper, or an average of 1.20 per cent, as compared with 1.22 per cent in 1913. The ores from Michigan excluded, which yielded an average of 0.89 per cent in 1914, the concentrating ores from the remainder of the United States yielded an average of 1.34 per cent, as compared with 1.29 per cent in 1913.

As shown in the table giving yield in copper, gold, and silver there has been a marked decrease in the tenor of copper ores treated during the last nine years, the average yield dropping from 2.50 per cent in 1906 to 1.60 per cent in 1914. The average yield of the smelting and the concentrating ores, considered separately, shows less change, the decrease in the average of total ores being due in part to a relative increase in the tonnage of concentrating ores.

Of the important copper-producing States Alaska yielded the highest grade of ore in 1914, the average yield being 6.64 per cent copper, California was second, with 3.84 per cent; Montana was third, with 2.66 per cent; Arizona was fourth, with 2.60 per cent; and New Mexico, Tennessee, Nevada, and Utah followed in the order named.

Of the States producing an important quantity of smelting ore, Arizona had the highest yield with 5.41 per cent, followed by Montana, with 5.08 per cent; California, with 3.84 per cent; and Utah and Tennessee with 1.82 and 1.44 per cent, respectively.

In the yield from concentrating ores Montana took first rank with an average of 2.24 per cent, followed by Arizona, with 1.49 per cent; New Mexico, 1.39 per cent; Nevada, 0.92 per cent; Michigan, 0.89 per cent; and Utah, 0.88 per cent.

Unusually high-grade ores were concentrated in Alaska, averaging 7.22 per cent, and the smelting ore averaged 6.83 per cent.

Since 1908 the average recovery from concentrating ores has decreased from 1.48 per cent to 1.20 per cent.

In 1914 copper ores yielded 264,824.99 ounces of gold and 14,829,760 ounces of silver, or an average of 0.0075 ounce of gold and 0.422 ounce of silver per ton. The total value of the gold and silver content of copper ores was $13,675,276, an average precious-metal value of 39 cents a ton. In 1913 copper ores yielded 0.0057 ounce of gold and 0.502 ounce of silver per ton, an average precious-metal value of 42 cents a ton. Exclusive of that portion of the Michigan ores from which the silver was not recovered, the average precious-metal content in 1914 was 49 cents a ton of copper ore, as compared with 49 cents in 1913 and with 62 cents in 1912.

Exclusive of the Michigan ores that did not yield silver, there was still included considerable ore from which the gold and silver values were not recovered, namely, that producing the casting copper from the Morenci Metcalf district, Arizona, and to a slight extent from other districts. This casting copper was not electrolytically refined, and consequently the precious-metal values were not recovered from it.

Among the important copper-producing States Alaska was first in the yield of gold and silver per ton of copper ore, the average being $2.17; California was second, $1.84; Montana third, $1.14; Arizona, $0.33; Utah, $0.39; Nevada, $0.39; New Mexico, $0.20; Tennessee, $0.09; and Michigan, $0.021.

REVIEW BY STATES.

INTRODUCTORY STATEMENT.

In the following pages a brief statement of the conditions affecting production in the principal districts of the country is presented, the geologic occurrence of the ores is briefly summarized, and the tenor of ore from each district is given when this will not disclose the production of individual companies, the figures of whose output have not already been published in their annual report or elsewhere.

Those desiring more detailed information of the mining operations of the districts are referred to the reports on mine production for the various States, which are published by the United States Geological Survey and which, with this and other reports, form the first part of the volume Mineral Resources of the United States for 1914, as shown in the prefatory note.

The report for 1910 contained a map showing the location of the principal copper-producing districts of the United States and the location of the principal reduction plants. The map has not been reproduced in this report, but copies can be obtained on application to the Director of the United States Geological Survey.

Where figures of metal output, ore reserves, and recovery in treatment of individual companies are given in this report, unless otherwise stated, it is to be understood that they are quoted from the official report of the company.

ALASKA.

The production of blister copper from Alaska in 1914 was 24,985,847 pounds, as compared with 23,423,070 pounds in 1913. The mine production of copper for 1914 was 21,450,628 pounds, the larger smelter production resulting from the treatment of some ore mined prior to 1914.

Important productions of copper from Alaska began about 1903, since which time it has been a steady contributor of that metal. To the close of 1914 its total production of blister copper has been 139,461,470 pounds. The output for 1914 was from the Ketchikan, Prince William Sound, and Copper River districts.

Ketchikan district.—Production in the Ketchikan district was again small in 1914 as for several years previous. The deposits of the district [1] thus far developed are of contact origin, the ores run high in iron, being composed of pyrrhotite, magnetite, pyrite, and chalcopyrite, and are desirable ores for the British Columbia and Washington smelters. The ores are shipped to the Tacoma smelter. Only the relatively high-grade ores are shipped, as the low-grade material can not be marketed profitably. The average yield in copper is between 4 and 5 per cent, and the ores carry rather low values in gold and silver.

Prince William Sound district.—Copper mining in the Prince William Sound district was active, the output being one of the largest made

[1] For detailed descriptions, see Wright, C. W., and Paige, Sidney, Mineral resources of Alaska in 1907: U. S. Geol. Survey Bull. 345, pp. 98–115, 1908; Wright, F. E., and Wright, C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, 1908; and Smith, P. S., Lode mining in the Ketchikan region, Alaska: U. S. Geol. Survey Bull. 592, pp. 75–94, 1914; Wright, C. W., Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska: U. S. Geol. Survey Prof. Paper 87, 1915.

by this district. The ores of the district were shipped to the Tacoma smelter. The deposits [1] consist of pyrrhotite, chalcopyrite, and pyrite, with minor quantities of other sulphides occurring chiefly in shear zones in greenstone and to a less extent in sedimentary rocks. The largest producer was the Beatson Bonanza mine, though the Ellamar mine was an important producer. Other copper properties were being developed. A concentrating plant was completed by the Beatson company.

Copper River district.—The Kennicott-Bonanza and Jumbo mines were the largest producers in the Copper River district. The Mother Lode Copper Mines Co., of the Chitina district, also produced in 1914.

The primary ores [2] of the Bonanza and Jumbo mines are principally chalcocite, with some bornite, replacing limestone near a greenstone contact. These minerals have been to slight extent altered to carbonates at the surface. This is one of the few important copper deposits known in which chalcocite, the principal ore mineral, is regarded as a primary mineral. Much of the ore is almost pure chalcocite and is of very high grade; the lower grade ore with a limestone gangue is susceptible of high concentration.

ARIZONA.

In 1914 Arizona produced 382,449,922 pounds of blister copper, as compared with 404,278,809 pounds in 1913.

The steady output of copper from Arizona began about 1875, though there was intermittent production prior to that date, the earliest record of production being for 1862. Since 1880 the growth of the industry has been steady and rapid. To the close of 1914 Arizona had a recorded production of 4,649,437,627 pounds of copper, or 23.24 per cent of the total output of the country, thus ranking third among the States in total production. Arizona produced 33.25 per cent of the total output of the country for 1914.

Nine copper-smelting plants were operated within the State during the year.

The greater part of the production was from five districts.

Bisbee district.—The Bisbee or Warren district, in southern Cochise County, was the largest producer, with about 151,600,000 pounds of blister copper, as compared with 155,100,000 pounds in 1913. Production in the district began in 1880, since which time it has been a constant and increasingly important contributor to the output of copper. To the close of 1914 it had produced 1,861,260,000 pounds of copper, or 9.30 per cent of the output of the country, and 40 per cent of the Arizona production. In total and in present output it ranks third among the copper districts of the country.

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[1] Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: U. S. Geol. Survey Bull. 443, pp. 87–96, 1910. Capps, R. S., and Johnson, B. L., Mineral deposits of the Ellamar district: U. S. Geol. Survey Bull. 542, pp. 86–124, 1912. Lincoln, F. C., The Big Bonanza copper mine, Latouche Island, Alaska: Econ. Geology, vol. 4, pp. 201–213, 1909. Thompson, A. P., On the relation of pyrrhotite to chalcopyrite and other sulphides: Econ. Geology, vol. 9, pp. 171–173, 1914.

[2] Moffit, F. H., and Maddren, A. G., Mineral resources of the Kotsina-Chitina region, Alaska: U. S. Geol. Survey Bull. 374, 1909. Moffit, F. H., and Capps, S. R., Geology and mineral resources of the Nizina district, Alaska: U. S. Geol. Survey Bull. 448, 1911.

The oldest rocks[1] in the Bisbee district, according to Ransome, are of the pre-Cambrian Pinal schist, which has been intruded by granite, probably also of pre-Cambrian age. On this basement were deposited upward of 5,000 feet of Paleozoic sediments, consisting for the most part of limestone with quartzite at the base. These beds were intruded in early Mesozoic time by stocks, dikes, and sills of granite porphyry. After a period of erosion Cretaceous sediments were deposited on the earlier formations, which have since been largely removed from the producing area.

The primary ores were deposited during and after the intrusion of the granite porphyry and were genetically connected with that intrusion. The presence of garnet, tremolite, diopside, and other silicates associated with the ore minerals indicates a contact origin of the deposits.

The principal ore bodies occur around the porphyry stock of Sacramento Hill and along faults and fissures where the ore minerals have replaced the limestone. The most important ore bodies thus far developed have been in the Carboniferous and Devonian limestones, but in recent years important deposits have been discovered in the Cambrian limestone, and ore has also been developed in the granite porphyry.

The following notes on the porphyry ores are taken principally from Mr. Jenney's description:

The disseminated ores occur in granite porphyry and "silica breccia" that is probably an alteration of the porphyry. Prior to October, 1913, two important bodies of ore had been developed by underground methods. From the Sacramento shaft a body of ore has been blocked out extending from the 400-foot to the 200-foot level, and approximately 300 feet by 100 feet in cross section with an east and west trend. From the air shaft a body has been developed between the 200-foot and 100-foot levels and above. An area about 800 feet by 200 feet has been blocked out. Since October, 1913, development by churn drill has been in progress. The ore consists of chalcocite, some bornite and chalcopyrite, and considerable pyrite in a siliceous gangue.

In the northern part of the district the ore deposits in the sedimentary rocks are frequently closely associated with porphyry bodies and this association serves to some extent as a guide in prospecting, but in the southern end of the district porphyry intrusions are less abundant and the ore bodies occur associated with fissures.

The primary ores of the district consist mainly of pyrite and chalcopyrite with smaller bodies of galena and some sphalerite. Alteration by surface solutions has extended to great depth and a large part of the ore extracted has been oxidized ore and secondarily enriched sulphide ore. In recent years, however, there have been developed large bodies of primary sulphides of commercial grade. Most of the

[1] For detailed geologic report, see Ransome, F. L., Geology and ore deposits of the Bisbee quadrangle, Arizona: U. S. Geol. Survey Prof. Paper 21, 1904; Rice, C. T., Camp of Bisbee, Arizona: Mines and Methods, Salt Lake City, Utah, vol. 1, p. 241, 1909; Weed, W. H., Is geology a success as a guide to ore deposits: Min. and Eng. World, vol. 27, p. 245; Douglas, James, Notman, Arthur, Legrand, Charles, and Lee, George B., The Copper Queen mines and works, Arizona, U. S. A.: Inst. Min. and Met. Trans., vol. 21, pp. 532–590, 1913; Eng. and Min. Jour., March 8, 1913; Ransome, F. L., Notes on the Bisbee district, Arizona: U. S. Geol. Survey Bull. 529, pp. 179–182, 1913; Jenney, J. B., Bisbee porphyry deposits: Eng. and Min. Jour., vol. 97, p. 467, 1914; Vail, R. H., The Copper Queen smelting works: Eng. and Min. Jour., vol. 99, pp. 1-6, 1915.

ore of the district occurs in irregular bodies without very definite arrangement and the cost of prospecting is consequently rather high. The irregular character of the ore deposits and the heavy ground, especially in the oxidized ore bodies, has resulted in relatively high cost of extraction. Recently, however, modifications in the system of mining have resulted in a decrease in the timber used per ton of ore and also in the cost of extraction. The cost of mining will, however, doubtless remain relatively high as compared with districts where cheaper systems of mining can be safely and economically employed.

Developments during 1914 resulted in a material increase in the ore reserves of the district.

For 1914 the average recovery was about 5.4 per cent copper and an average precious metal value of $1.35 per ton of ore.

The following table shows the production of the Copper Queen mine:

Production of the Copper Queen Consolidated Mining Co. in 1914.

	Dry weight.	Gold.	Silver.	Copper.	Lead.
Shipped to Douglas:	*Short tons.*	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*
Ore	674,365	13,660	692,577	82,932,860	.....
Precipitates	584	.....	72	354,792	.....
Ore from lessees	10,807	67	5,457	1,543,948	.....
Old dump slag by lease	11,502	.....	828	469,175	.....
Ore for experimental leaching plant	3,393	4	154	93,191	.....
Shipped to Globe: Sulphide ore	5,098	216	5,447	142,729	.....
Shipped to El Paso:					
Ore mined by company	23,304	1,704	329,049	389,893	8,639,465
Ore mined by lessees	626	118	3,088	9,213	249,710
Delivered to experimental concentrator	3,150	.....	.....	130,342	.....
Total	732,829	15,769	1,036,672	86,066,143	8,889,175

The company reports at the close of 1914 developed ore reserves of the limestone deposits, mine run, of 2,834,862 tons and of lean sulphide 257,077 tons, a total reserve of this type of 3,091,939 tons. This does not include the porphyry ores already mentioned, which are stated to be "several million tons." The company reports net earnings of $6,042,001.07. Dividends paid in 1914 amounted to $4,500,000. Experiments were conducted in a 90-ton plant to determine a method of treatment for the ores of Sacramento Hill. By a combined hydraulic and flotation method a recovery of 87 per cent was obtained.

The Calumet & Arizona Mining Co. produced a total of 49,992,909 pounds of refined copper, 573,606 ounces silver, and 19,774 ounces gold. A total of 668,776 dry tons of ore were treated at the smelter during the year, consisting of Calumet & Arizona Mining Co. ore, 64,701.83 tons; Superior & Pittsburg Co. ore, 465,348.69 tons; and custom ores, 138,725.74 tons. The net income of the Calumet & Arizona and subsidiary companies for 1914 was $3,085,535.50.

The Shattuck Arizona Copper Co. produced at normal capacity till August, when shipments were curtailed 50 per cent and were stopped October 23, awaiting more favorable market conditions.

The following summary from the company's annual report gives the production for the year.

Summary of mine and smelter production of the Shattuck Arizona Copper Co. for the year 1914.

	Copper ore.		Lead ore.	
	Wet.	Dry.	Wet.	Dry.
Tons ore stoped	89,119	80,738	.....	.....
Tons development ore	3,770	3,416	.....	.....
Tons ore mined	92,889	84,154	.....	.....
Tons ore shipped	93,087	84,317	53	52
Tons ore smelted	93,629	84,801	53	52
Pounds recovered per ton	115.85	127.91	263.80	270.50
Per cent bullion recovered per ton	5.79	6.39	13.19	13.52
Total pounds copper recovered	10,846,918			
Total ounces silver recovered	198,419			
Total ounces gold recovered	2,444.91			
Total pounds lead recovered	14,065			
Value of gold and silver per dry ton of ore smelted	$1.91			
Precious metal values per ton of refined copper	$29.80			
Lead ore credits per ton of refined copper	.46			
Net cost per pound of refined copper	[a] 8.472			

[a] Cents.

At Douglas the plants of the Copper Queen and the Calumet & Arizona companies were operated throughout the year.

The district is served by the El Paso & Southwestern Railroad. Oil for fuel is used extensively in the production of power, which is generated in central plants and distributed to the places where needed.

Morenci-Metcalf district.—The deposits of the Morenci-Metcalf district are at Morenci and Metcalf, in Greenlee County. During 1914 the district produced 66,000,000 pounds of blister copper, as compared with about 70,100,000 pounds in 1913.

The district was one of the earliest copper producers in the State, the output beginning as early as 1873, and since 1880 it has been an important contributor to the copper output of the country. To the close of 1914 a total of 1,170,200,000 pounds of copper had been produced, or 5.85 per cent of the output of the country since 1845, and 25 per cent of the output of the State. In total production it ranks fourth among the copper districts of the country, and second in the State; in the output for 1914 it ranks sixth in the country, and third in the State.

The copper ores[1] of this district occur as contact deposits in Paleozoic limestones and shales which have been intruded by stocks and dikes of poryphery, as disseminated deposits mainly in the porphyry, and as deposits in fault fissures of the Coronado type.

The original ores were pyrite and chalcopyrite of too low grade to be of economic importance. The workable bodies have resulted from the process of secondary enrichment. The ore bodies in the limestone were formed in certain beds favorable to deposition, and this produced roughly tabular bodies nearly parallel to the stratification of the limestone. Alteration of these bodies has produced oxidized ores which formed most of the workable ores in the limestone. These are now nearly exhausted.

The disseminated ores occur in highly altered porphyry adjacent to fissure veins. The copper content of the upper portion of these

[1] For detailed report of the Clifton-Morenci district see Lindgren, Waldemar, The copper deposits of the Clifton-Morenci district, Arizona: U. S. Geol. Survey Prof. Paper 43, 1905; Tovote, W. L., Min. and Sci. Press, vol. 101, p. 770, 1910.

deposits has been leached and deposited as chalcocite on the pyrite lower down. This has produced a zone of commercial ore varying in thickness, in general not extending below a depth of 400 feet.

In the fault fissure or Coronado type of deposit commercial ore has been developed to much greater depth, and recent exploration of the principal faults in Copper Mountain has shown that commercial ore occurs associated with these faults considerably below the general level of the ore zone.

In 1914, of the mine production of copper, 49,964,000 pounds were derived from concentrating ores, and 15,220,000 pounds from smelting ores. The mines of the district produced 1,513,864 tons of concentrating ores, yielding an average of 1.65 per cent copper, and 161,713 tons of smelting ore, yielding an average of 4.7 per cent copper—the average yield for the 1,684,481 tons of ore produced in the district being 1.95 per cent.

The ores in general carry low values in gold and silver, and as much of the copper is of sufficient purity for commercial purposes it is not refined electrolytically, and consequently the precious-metal content is not recovered.

Modified systems of slicing and caving are now very largely employed in the extraction of ore, and the amount of timber required has thus been very materially reduced from what it was when the square set method prevailed.

The following table gives a summary of the production of the mines of the Detroit Copper Co. for 1914:

Production of ore of the Detroit Copper Co., Arizona, in 1914, in short tons.

	Quantity.	Grade.
		Per cent.
Concentrating ore	459,473	2.797
Smelting ore	5,434	9.99
Quartz ore	7,159	4.452
Talc	128	3.842
Lease ore, miscellaneous:		
Montezuma	28.8	5.34
London	23.1	4.71
Thomson	55.98	7.59
Copper Bullion	241.84	15.20
Imperial	38.9	10.28
Daisy	10.9	7.18
De Soto	13.8	12.39
Black Jack	5.8	10.00
Blue Jay	16.5	11.51
Hoodoo	4.9	13.47
Yankie	93.87	15.58
Copper Mountain	101.86	11.14
Lone Star	75.35	21.19
Copper precipitates	61.70	52.13
Total	472,967.3	2.922

The following table shows the result of concentrating operations of the Detroit Copper Co. during 1914:

Result of concentrating operations of the Detroit Copper Co. during 1914.

	Short tons.	Percentage of copper.
Ore concentrated	460,797.6	2.794
Concentrates produced	60,264.8	15.729

The following table shows the result of smelting and converting operations of the Detroit Copper Co. for 1914:

Result of smelting and converting operations of the Detroit Copper Co., for 1914.

Ore, concentrates and flux smelted	short tons	89,054.7
New copper bearing material smelted	do	81,750.5
Copper contained to account for	do	10,620.35
Copper produced	do	10,137.181
Metallurgical loss	do	483.169
Loss in slag	do	208.029
Unaccounted for	do	275.140
Recovery	per cent	95.45
Copper in matte	do	36.00
Copper in slag	do	.35
Coke to total charge	do	11.33
Limestone to total charge	do	5.64

The Detroit Copper Co. reported net earnings for the year of $602,318.91. Dividends were paid in 1914 to the amount of $280,000.

During the fiscal year ending September 30, 1914, the Arizona Copper Co. (Ltd.) produced 38,942,455 pounds of copper. The company's mines produced 1,079,950 dry tons of ore. The average yield in copper per ton of ore treated was 36.17 pounds, or 1.8085 per cent. This compares with a yield of 1.938 per cent for the preceding year. Of the total ores, 95 per cent were concentrating ores and 5 per cent smelting ores. Of the total copper produced, 81.4 per cent came from sulphide ores and 18.6 per cent from oxidized ores.

During the year the oxide concentrator treated 87,875 dry tons of ore, tailings from which, amounting to 72,649 dry tons, were treated by the leacher. This ore yielded 5.7 per cent of the total copper produced.

The sulphuric acid plant supplied the leacher with 2,937 tons of acid.

The new smelting works [1] began operation in August, 1913, and from that time there was a reduction in the operations at the old plant, which was finally closed at the end of the year 1913.

Production by the Shannon Copper Co. for 1914 amounted to 9,003,169 pounds of copper, 1,295 ounces of gold, and 60,603 ounces of silver. During the same period 154,317 tons of ore were produced from the Shannon mine.

The average cost of copper for the period was 12.26 cents a pound. The net profits for the period amounted to $95,648.88.

The mines and smelters were closed during the last quarter of the year on account of the unfavorable market conditions for copper.

Jerome district.—The Jerome or Verde district of Yavapai County produced about 30,000,000 pounds of blister copper in 1914, as compared with about 35,300,000 pounds in 1913. The production of copper in the district began about 1883, though it had yielded gold and silver prior to that time. Since 1888 it has been a steady and important producer.

To the close of 1914 it has produced a total of 700,180,000 pounds of copper, or 3.50 per cent of the total output of the country since 1845, and 15 per cent of the total output of the State. In total

[1] The new plant has been fully described by R. H. Vail (Eng. and Min. Jour., vol. 97, pp. 1279-1283; vol. 98, pp 11-16, 1914).

output it stands sixth among the copper districts of the country and third in Arizona. In output for 1914 the district ranks tenth among those of the country and fifth in Arizona.

The rocks [1] in which the United Verde deposit occurs are pre-Cambrian schistose rocks, resulting from the metamorphism of dioritic, rhyolitic, and possibly sedimentary rocks. The material most favorable to replacement by ore is a fissile sericitic schist.

According to Ransome:

> The ore shoot as a whole is of oval plan, its total horizontal length being about 1,300 feet and its greatest width 700 feet. Its general trend is north-northwest and it pitches in that direction at an angle of 45°. It has been worked to a vertical depth of 1,200 feet with no sign of approaching exhaustion. This great shoot is in reality a complex of smaller but nevertheless large irregular or lenticular ore bodies, apparently related in part to cross fissuring but showing a general tendency toward parallelism with the schistosity.
>
> The important ore constituent is chalcopyrite, associated with varying proportions of pyrite and sphalerite. Bornite has been reported but was not noted in 1912. Neither galena nor pyrrhotite was observed at the time of visit. The sulphides occur partly in small irregular fractures and along planes of schistosity, but to a large extent they have metasomatically replaced the schist, particularly the fine-grained sericitic variety. The ore contains very little vein quartz or other gangue mineral.
>
> The sulphides mentioned are primary and were deposited in pre-Cambrian time.

The ores differ from most of the large copper deposits of Arizona in carrying rather high gold and silver values. The copper content of the ore is also unusually high for this type of deposit.

As little timber as possible is employed in mining on account of the danger from fire.

Considerable copper is recovered by precipitation on scrap iron from the mine waters that have leached through the burning stopes.

The United Verde Copper Co. was the only important producer during the year. This company has constructed a new smelting plant [2] for the treatment of its ores at Clarkdale, on the west side of Verde River, about 5 miles from Jerome.

Development was carried on by other companies in the district during the year, but no important production was made. The district is served by a narrow-gage railroad owned by the United Verde Copper Co., which connects with the Santa Fe, Prescott & Phoenix Railway.

Globe district.—The Globe district of Gila County produced about 72,800,000 pounds of blister copper in 1914, as compared with about 71,000,000 pounds in 1913.

Production of copper began in the district in 1881; the camp was well known as a silver producer before that date. For several years subsequent to 1881 the production was intermittent; but since 1888, and especially since 1898, when the railroad reached the camp, the district has ranked among the important copper producers of the country. To the close of 1914 it has produced a total of 584,700,000 pounds of copper, or 2.92 per cent of the output of the country since 1845, and 12.5 per cent of the output of the State. In total production the district ranks seventh in the country and fourth in the State; for 1914 it ranked fifth in the country and second in the State. Important production began in the Miami section in 1911, and this section of the district will continue to grow in importance.

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[1] Graton, L. C., U. S. Geol. Survey Mineral Resources, 1907, pt. 1, p. 597, 1908; Ransome, F. L., U. S. Geol. Survey Bull. 529, p. 192, 1913. Tupper, C. A., Mine and smelter of the United Verde Copper Co.: Min. World, vol. 42, pp. 717–727, 1915.

[2] The new plant is described by R. H. Vail (Eng. and Min. Jour., vol. 96, pp. 287–292, 1913).

The geology [1] of the district may be briefly summarized as follows: Paleozoic sediments, consisting of conglomerates, quartzites, shales, and limestones, were laid down unconformably on a pre-Cambrian basement of schist and intruded granitic rocks. In post-Paleozoic time the region was invaded by an intrusion of diabase followed by an intrusion of granitic rock. After a period of erosion the area was partly or wholly buried beneath Tertiary volcanic and sedimentary rocks which have since been partly removed by erosion.

The copper deposits are believed to have been introduced at the time of or closely following the post-Paleozoic granitic intrusion, and the source of the copper-bearing solutions is believed to have been connected with this igneous rock. The deposits of the district are of quite different types, dependent largely upon the nature of the rocks in which they were formed. In the Globe end of the district the deposits occur as roughly lenticular deposits replacing limestone, and as fault lodes or fissure zones of quartz and sulphide in diabase.

In the Miami end of the district the ores occur mainly as small veins of quartz and sulphide in the shattered rock near the granite schist contact, the mineralization occurring in both formations.

In the Globe section of the district most of the ores developed to the present time owe their commercial value to enrichment. The ore extracted from the limestone has been largely oxidized, and much of the ore developed in the diabase has been enriched sulphide. Under favorable conditions the enrichment has gone on to the greatest depth to which development has extended. Some bodies of primary ore of commercial grade have also been developed.

In the disseminated bodies of the Miami section the original ore was sulphides of iron and copper. The copper content of the ores near the surface has been partly taken into solution and redeposited as chalcocite on the sulphides lower down. The commercial ore consists of grains of pyrite and chalcopyrite partly or wholly replaced by chalcocite. The commercial bodies of ore are blanket-like deposits overlain by leached "capping" and underlain by primary material too lean in copper content to be classed as commercial ore.

In places overlying the sulphide ore there is a considerable quantity of oxidized and partly oxidized ore of a grade that will permit of extraction when a satisfactory method of recovering the metal is available.

An exceptional type of ore is that of the Black Warrior mine, which is oxidized ore cementing dacite tuff or breccia.

The ores in the Globe end of the district vary greatly in copper content, the grade to be treated at any given time depending largely on the possibility of profitable treatment. In general, ores of as low grade as can be handled with reasonable profit are mined. During 1914 the ores of the entire district yielded about 2.41 per cent of copper, with about 13 cents in gold and silver per ton. The mines of the district produced 1,334,907 tons of concentrating ore, yielding an average of 1.26 per cent copper, and 174,869 tons of smelting ore, yielding an average of 7.18 per cent copper.

[1] For detailed description, see Ransome, F. L., Geology of the Globe copper district, Arizona: U. S. Geol. Survey Prof. Paper 12, 1903; Geology at Globe, Ariz.; Min. and Sci. Press, vol. 100, p. 256, 1910; Geology of the Globe district, Ariz.; idem, vol. 102, p. 747, 1911; Tolman, C. F., jr., Min. and Sci. Press, vol. 99, p. 646, 1909; Higgins, Edwin, Eng. and Min. Jour., vol. 89, pp. 769, 813, 870, 1910; Ransome, F. L., U. S. Geol. Survey Bull. 529, pp. 183–185, 1913; Tovote, W. L., Globe mining district, Ariz.; Min. and Sci. Press, vol. 108, pp. 442–449 and 487–492, 1914.

The Old Dominion smelter was the only reduction plant operating in the district during the year.

The International Smelting & Refining Co. had under construction a smelter to treat the concentrates of the Inspiration Consolidated mine. This plant was put into operation in May, 1915.

The district is served by the Arizona Eastern Railroad.

The Old Dominion and the United Globe mines at Globe and the Miami mine at Miami were the largest producers during the year.

The ore produced by the Old Dominion Co. is shown below.

Ore produced by Old Dominion Copper Mining & Smelting Co., Arizona, in 1914.

	Quantity (short tons).	Percentage of copper.
Smelting ore	99,507	8.28
Concentrating ore	30,159	4.69
Silica lining	147	3.12
Total	129,813	7.44

The ores of the Old Dominion mine yielded 17,816,284 pounds of copper, 33,311 ounces silver, and 603 ounces gold.

Net earnings of the company for the year were $978,509.81, and regular dividends were paid amounting to $445,500. A special dividend was paid amounting to $1,620,000. The cost of producing copper for the year was 8.22 cents a pound.

The following table shows the production of the United Globe mines for 1913:

Ore produced by United Globe mines, Arizona, in 1914, in short tons.

	Quantity.	Percentage of copper.
Smelting oxide	14,351.84	6.38
Smelting sulphide	12,639.67	1.69
Concentrating ore	121,811.57	3.23
Silica converter lining	6,401.93	7.44
Total	155,205.01	3.57

The total metal production was 11,086,674 pounds of copper, 91,582 ounces of silver, and 1,580 ounces of gold.

Net earnings for 1914 amounted to $432,538.11, and dividends to the amount of $425,500 were paid.

The following table shows the results of milling operations of the Miami Copper Co.:

Milling operations of Miami Copper Co., Arizona, in 1914.

Ore milled	short tons	1,096,633
Copper in ore	per cent	2.28
Concentrates produced	short tons	44,579
Copper in concentrates	per cent	39.31
Copper in concentrates	pounds	35,048,445
Copper recovered per ton of ore	do	31.96
Mill extraction	per cent	69.93

The net smelter returns of refined copper from concentrates amounted to 33,296,010 pounds. The cost of copper in concentrates on board cars at Miami was as follows:

Cost of copper f. o. b. cars at Miami in 1914.

	Per ton of ore.	Per pound of copper.
Mining	$1.18756	$0.039205
Milling	.49963	.016456
General	.27176	.008951
Total	1.95895	.064612

The total cost of producing and marketing copper for the year was 9.2045 cents a pound.

On January 1, 1915, the ore reserves were estimated as 19,500,000 tons of sulphide, with an average copper content of about 2.40 per cent. There is also developed 17,000,000 tons of material averaging 1.21 per cent copper. In addition developments indicate a body of oxidized or partly oxidized ore which contains about 6,000,000 tons, averaging about 2 per cent copper. During 1914 the company paid dividends to the amount of $1,120,375.

During 1914 the Inspiration Consolidated Copper Co. continued the preparation of its mine for the extracton of ore and the construction of the mill.

The milling treatment adopted is summarized as follows by the general manager, C. E. Mills:

At the mine: Crushing ore to 4-inch maximum size in gyratory crushers; crushing this ore to 1½-inch maximum size by Symons disk crushers.

At the mill: Crushing this product in Marcy ball mills to pass 48-mesh screen; treatment of this product in flotation machines; separation of flotation tailings into sand and slime; treatment of sand on concentrating tables; re-treatment of slime in flotation machines; dewatering concentrates in filter plant.

It is stated that by this treatment over a period of several months a recovery of 86.7 per cent of the copper occurring in the ore in sulphide form was made, and that a recovery of 90.3 per cent was attained for one month. The recovery of copper in oxide form is estimated at 20 to 30 per cent.

During 1914 the test mill treated 172,722 tons of ore averaging 1.52 per cent copper, produced from the development work of the mine; 28 per cent of this came from without the ore body, i. e., from low-grade ore pierced by the drifts and raises driven from below the regular ore body. The Inspiration concentrates will probably run from 28 per cent to 32 per cent copper and contain sufficient sulphur to make a suitable grade of matte in smelting.

The surface equipment now nearing completion is very substantially built of steel and concrete.

The ore to be hoisted will be delivered to one set of double concrete bins under ground holding 3,700 tons and hoisted to surface through twin concrete-lined shafts, delivering to a bin of 2,000 tons capacity located between the shafts. The total lift will be 630 feet and the capacity of the hoisting equipment and the coarse crushing plant to which it delivers the ore will be 1,000 tons per hour, sufficient to take care of any probable future increase of output. The ore will be hauled 1.6 miles in 60-ton railroad cars from a 25,000-ton mine storage bin to a 12,000-ton mill storage bin.

The mill will consist of 18 sections, each one of which, it is expected, will have a capacity of 800 tons per day. The first 9 of these sections we expect to complete almost simultaneously, giving substantially the milling capacity contemplated in

the original plans. The other sections will be completed in rotation and will be ready to operate before the end of this year.

The mine and mill are connected both with the United States Reclamation hydroelectric plant and with our steam plant, consisting of three 6,000-kilowatt turbogenerator units.

* * * * * * *

The mining system to be put in use will consist of undercutting and thus caving the ore in blocks of probably 70 feet vertical dimension, the broken and caved ore to be drawn off through a system of inclined raises delivering to the haulage ways below; these raises to have sufficient number of branches immediately below the caved area to reduce the interval to a minimum, probably 8 feet, between the heads of the raises that tap the caved ore.

At the end of the year negotiations were concluded for the property of the New Keystone Co., which lies between the Inspiration and Live Oak divisions of this company's mine and the transfer has been effected. The ore reserves in this ground are believed to be completely developed. Those based on churn-drill records are given below in connection with the previously reported tonnage of the Inspiration and Live Oak divisions which are likewise based on churn-drill records. The consolidated statement is as follows:

Ore resources of Inspiration Consolidated Copper Co., Arizona, Jan. 1, 1915, in short tons.

Classification of material.	Developed in original exploration.		Developed by drilling in 1913.		Originally developed but not reported.		Keystone ore through purchase of property, 1914.		Total.	
	Quantity.	Percentage of copper.	Quantity.	Percentage of copper.	Quantity.	Percentage of copper.	Quantity.	Percentage of copper.	Quantity.	Percentage of copper.
Sulphide ore	45,000,000	2	.....	.....	.....	.....	1,252,000	2.24	46,252,000	2.01
Low sulphide material	.....	.....	2,839,000	1.45	25,483,000	1.24	376,000	1.13	28,698,000	1.26
Oxidized material	.....	.....	3,767,000	1.33	8,678,000	1.34	5,015,300	1.25	17,460,300	1.31
Mixed carbonate and sulphide material	.....	.....	252,000	1.53	3,624,000	1.22	856,700	1.62	4,732,700	1.31
Total	45,000,000	2	6,858,000	1.39	37,785,000	1.26	7,500,000	1.45	97,143,000	1.63

Mineral Creek or Ray district.—The Mineral Creek or Ray district, Pinal County, produced 57,000,000 pounds of blister copper in 1914, as compared with 52,340,000 pounds in 1913. Important production in the district began in 1911. The total output to the close of 1914 has been 159,640,000 pounds.

The geology [1] of the district is very similar to that of the Globe district to the north. Paleozoic sediments have been deposited on a basement of pre-Cambrian schists. In post-Carboniferous time the region was invaded by an intrusion of diabase and later by a granitic intrusive of varying composition. After a period of erosion the area was buried beneath Tertiary volcanic and sedimentary rocks. Later it was elevated, faulted, and the covering of Tertiary sediments partly removed. The ore deposits of the district are of two distinct types—those formed in the sedimentary rocks adjacent to faults and

[1] Ransome, F. L., Geology of the Globe district, Arizona: Min. and Sci. Press, vol. 102, p. 747, 1911; Weed, W. H., The Ray copper mining district, Arizona: Mining World, vol. 34, p. 53, 1911; Tolman, C. F., jr., Disseminated chalcocite deposits at Ray, Ariz.: Min. and Sci. Press, vol. 99, p. 622, 1909; Clifford, J. O., Ray Consolidated properties: Mines and Methods, Salt Lake City, Utah, vol. 4, p. 83; Ransome, F. L., U. S. Geol. Survey Bull. 529, p. 186, 1913.

fissures, and the disseminated deposits in the schists and granite. The ores of both types are believed to have been introduced at the time of and closely following the granitic intrusion.

The deposits of the first type are found east of the Ray fault. The ores are mainly oxidized. To the present time important production has not been made from this type, nor have large ore reserves been developed.

The disseminated deposits occur in crushed schists and "granite." The original mineralization was pyrite and chalcopyrite, but the commercial ore has resulted from enrichment of the deposits produced by the leaching of the copper values from the upper portion and the redepositing them as chalcocite on the sulphides lower down. This has resulted in a blanket-like deposit of commercial ore covered by a relatively barren capping and underlain by a zone of original mineralization too low in copper content to be of commercial value.

The average thickness of the leached zone or "capping" in the Ray Consolidated ground is 252 feet, and the average thickness of the ore 101 feet. Locally, especially associated with the diabase, native copper becomes of some importance.

The district is served by the Arizona Eastern Railroad. The mines and reduction works are connected by the Ray & Gila Valley Railroad, controlled by the Ray Consolidated Copper Co.

Ore reserves of the Ray Consolidated Co. at the beginning of 1915 were estimated at 74,765,789 tons, averaging about 2.214 per cent copper.

A total of 2,427,700 tons of ore with an average copper content of 1.76 per cent was milled and yielded in concentrates 58,020,955 pounds of copper. The average recovery in concentrates was 67.88 per cent, or 23.9 pounds per ton. In addition to copper in concentrates crude smelting ore with a copper content of 1,023,745 pounds was shipped. The average cost of copper for the year was 8.839 cents a pound. The net profit for the year was $2,395,623.40. Dividends were paid to the amount of $1,089,321.95.

The concentrates were treated at the plant of the American Smelting & Refining Co., at Hayden.

Silver Bell district.—As for several years past, there was little activity in the Silver Bell district of Pima County. This district has yielded about 41,800,000 pounds of copper.

Turquoise district.—Shipments of copper from the Turquoise district during the year amounted to about 1,586,000 pounds. The Paleozoic sediments [1] of the district have been extensively faulted and intruded by monzonitic porphyries. The copper deposits of the district may be grouped as follows:

(1) Oxidized blanket deposits connected with thrust faulting, exemplified by the ore bodies of the Germania and Mary mines. (2) Pyritic deposits with some associated bodies of oxidized ore in the Cambrian dolomitic limestone and shale, exemplified by the Mame and Leadville mines. (3) Pyritic deposits with associated bodies of oxidized or enriched ore in Carboniferous limestone, exemplified by the Copper Belle and other mines near Gleeson.

Ajo district.—The Calumet & Arizona Copper Co. has developed extensive deposits of disseminated ore on the property of the New

[1] Ransome, F. L., The Turquoise copper-mining district, Arizona: U. S. Geol. Survey Bull. 530, pp. 125–134, 1912.

Cornelia Copper Co., at Ajo, Pima County, about 45 miles from the Southern Pacific Railroad at Gila Bend.

The company estimates the ore as follows: Carbonate ore, 11,954,400 tons, averaging 1.54 per cent copper; sulphide ore, 28,303,600 tons, averaging 1.50 per cent copper; total, 40,258,000 tons, averaging 1.51 per cent copper. Of this, 11,954,400 tons of carbonate ore and 20,526,800 tons of sulphide ore are available for steam-shovel mining. The rocks [1] of the district consist of a series of lavas, breccias, and tuffs which have been intruded by stocks of quartz monzonite porphyry and allied rocks. The original copper deposits consist of small veins containing chalcopyrite and bornite for the most part in the intrusive rock but also present in the extrusive rocks. Oxidation has been extensive, but there has been no important leaching of the copper from the oxidized ores. It is proposed to extract the copper from the oxidized ores by a leaching process.[2]

A small experimental plant was operated in the district for a part of the year determining a method of treatment for the oxidized ores. The company reports that an extraction of about 80 per cent was attained in the treatment of the oxidized ores. Later a 40-ton plant was completed further to test the process.

Other districts of the State making important production were the Big Bug, Yavapai County; Cochise, Cochise County; the Palmetto and Patagonia, Santa Cruz County; the Pioneer and Bunker Hill, Pinal County; the Pima, Pima County; the Bentley, Mohave County; and the Bonner, Gila County.

CALIFORNIA.

In 1914 California produced 29,784,173 pounds of blister copper, as compared with 32,492,265 pounds in 1913. The reduction in output for the State in recent years is due to the necessity of eliminating from the smelter "smoke" ingredients injurious to vegetation, which has resulted in the shutting down of all but one of the smelters in the Shasta County district.

California was among the earliest of the Western States to make a considerable output of copper. Production began in the "foothill" belt about 1862 and for several years was a valuable industry, California being second only to Michigan in its copper production. In a few years, however, the industry declined, and California did not attain important rank as a copper producer until 1897, when production from the Shasta County district began. Since that time there has been a steady and important output from the State. The production for the early years has been ascertained from the best sources available, and adding to this the known production since 1882, it is found that to the close of 1914 California has produced about 574,763,517 pounds of copper, or 2.87 per cent of the output of the country since 1845. In 1914 the output was 2.58 per cent of the total production of the United States. In total output the State ranks fifth among the copper producers of the country, and for 1914 it ranked seventh. Three plants in the State treated copper ores in 1914.

[1] Joralemon, I. B., The Ajo copper mining district: Am. Inst. Min. Eng. Trans., vol. 49, pp. 593–609, 1914.

[2] Croasdale, Stuart, Leaching experiments on the Ajo ores: Am. Inst. Min. Eng. Trans., vol. 49, pp. 610–658, 1914.

The main production has come from two districts, though numerous other districts have made small outputs, and copper minerals are widely distributed over the State. The largest producer has been the Shasta County district and the next most important the "Foothill" district.

Shasta district.—The Shasta County copper belt is situated in the Klamath Mountains, at the head of the Sacramento Valley, a few miles north of the town of Redding. Sacramento River crosses the velt, separating it into an eastern and a western portion, the eastern portion containing the Bully Hill and the Afterthought districts, and the western, the Iron Mountain and the Little Backbone districts. Placer mining was carried on in the district in the early days of mining in the State, and later considerable silver was produced from the gossan outcrop of the copper deposits. Copper minerals had been long known in the district, but not until 1897, when the Mountain Copper Co. (Ltd.) began production at Iron Mountain, did the district become an important contributor of copper. In 1914 the district produced about 25,100,000 pounds of copper, as compared with about 26,800,000 pounds in 1913. The total production to the close of 1914 has been 443,800,000 pounds, or 2.22 per cent of the total output of the country. In 1914 the district produced 2.18 per cent of the total output. In total output the district ranks eighth and in the production for 1914 it ranked eleventh among the copper districts of the country.

The inclosing rock [1] of most of the ore bodies is an intrusive alaskite porphyry of Mesozoic age. The ore minerals have replaced this rock along fissures and zones of shearing. In the western district the largest deposits thus far developed are large flat-lying, more or less tabular bodies of no great vertical extent. Deposits having more the character of veins and containing a relatively high percentage of chalcopyrite have become important in recent years. In the eastern district they have more definitely the character of veins and locally form deposits in the adjoining sediments.

The sulphide lenses in the western district contain pyrite, with a small percentage of chalcopyrite and varying quantities of sphalerite which, in some instances, becomes sufficiently abundant to to constitute a commercial zinc ore. The vein deposits are siliceous and contain a relatively high percentage of chalcopyrite. In the eastern district sphalerite becomes an important constituent.

Rich secondary sulphide ores were found underlying the gossan at Iron Mountain and Bully Hill, but these have been exhausted.

The ores carry values in precious metals, those of the eastern district being rich in them. The average metal content of the copper ores from the district for 1914 was 3.56 per cent of copper, with $1.70 per ton in precious metals.

The principal producing companies in 1914 were the Mountain Copper Co., the Mammoth Copper Co., and the Balaklala Copper Co. The ores of the Mammoth Co. were smelted at its plant at Kennett, and the Mountain Co.'s ores were smelted at its Martinez plant on San Francisco Bay. The Balaklala ores were shipped to custom plants.

[1] Diller, J. S., U. S. Geol. Survey Geol. Atlas, Redding folio (No. 138), 1906; U. S. Geol. Survey Bull. 213, pp. 123–132, 1903; U. S. Geol. Survey Bull. 225, pp. 169–179, 1904. Graton, L. C., The occurrence of copper in Shasta County, Cal.: U. S. Geol. Survey Bull. 430, p. 71, 1910. Boyle, A. C., Geology and ore deposits of the Bully Hill mining district, Cal.: Am. Inst. Min. Eng. Bull., January, 1914, pp. 57–105.

The shipment of ore from the Mammoth mine amounted to 235,146 tons. The company reports that ore developed during the year was more than sufficient to replace that extracted.

The Iron Mountain Co. treated 90,738 tons of ore during the year, derived as follows: Iron Mountain mine, 22,066 tons; No. 8 mine, 27,078 tons; Hornet mine, 41,131 tons; purchased, 463 tons.

A report dated March 20, 1915, gives an approximate estimate of the ore reserves, as follows: Old mine, about 3,000 tons; No. 8 mine, positive ore 112,000 tons and probable ore 95,000 tons; Complex mine, 21,000 tons developed, 75,000 tons probable ore. In addition the Hornet mine contains a large body of low-grade ore.

Construction on the concentrating and sorting plant at Minnesota was in progress during the year, and the plant went into operation in 1915.

The Balaklala smelter was idle, but ore was shipped from the mines to custom smelters.

Electric power is used almost exclusively at both mines and smelters.

The district is served by the Southern Pacific Railroad, short branches extending to the smelters. The Iron Mountain district is connected with the main line by a narrow-gage railroad operated by the Mountain Copper Co., and the mines of the Mammoth Co. are connected with the smelter by a combined electric railroad, gravity tram, and steam railroad. The ores of the Balaklala mine are delivered to the railroad over a cable tramway.

"Foothill" district.—The "foothill" belt, is a rather extensive area of copper deposits which has its best development in Calaveras County. This belt furnished practically the entire copper production from California in the sixties. Subsequent to that period of activity, the district was inactive for many years. From 1887 to 1892 the mines made some production. The present period of activity began about 1901, and for some years the district has made important contributions to the copper output of the State.

There is no accurate record of the output of this district in the early days, but from the records of the production of the State it is estimated that to the close of 1914 it has yielded approximately 125,700,000 pounds of copper. The production for 1914 was approximately 4,400,000 pounds. In total output the district ranks twelfth, and in production for 1914 it ranked seventeenth among the copper districts of the country.

The ores [1] consisting of pyrite and chalcopyrite occur as lenticular bodies, replacing schistose rocks. The ores vary in different parts of the district from those carrying nearly pure pyrite and chalcopyrite with very low gold and silver content to ores carrying considerable lead, zinc, and precious metal. The ores treated during 1914 averaged about 5 per cent in copper, with about 2.8 cents in precious metal per pound of copper.

The principal production was made by the Penn Mining Co., Campo Seco, and the Calaveras Copper Co., Copperopolis. The matte smelter of the Penn Mining Co. was operated in the district.

A concentrating plant employing the flotation process was put in operation at the Engels mine, Plumas County, during the year.

[1] Knopf, Adolph, California Univ. Dept. Geology Bull., vol. 4, p. 411. Read, J. A., Econ. Geology, vol. 2, p. 380, 1907. Lang, Herbert, Eng. and Min. Jour., vol. 84, p. 909, 1907.

COLORADO.

In 1914 Colorado produced 7,316,066 pounds of blister copper, as compared with 9,052,104 pounds in 1913. Although the State has no important producing district in which copper is the principal metal, yet it ranked tenth among the copper-producing States in 1914. The total recorded output for the State from the beginning of the industry has been 237,875,614 pounds, or 1.19 per cent of the total output for the United States since 1845. It is probable that the actual output is somewhat in excess of this figure, as some of the copper assigned in the earlier Survey reports to "lead desilverizers" should doubtless be credited to Colorado.

The main production has been derived from the treatment of mixed ores in which copper was of minor importance, including lead-silver ores and pyritic ores rich in gold and silver. The largest production in 1914 was from Lake County and from San Juan, Ouray, San Miguel, Clear Creek, Chaffee, Dolores, Gilpin, and Fremont counties. Leadville and the San Juan-Ouray districts have been the greatest producers of copper. Much of the output is recovered as matte in lead furnaces.

IDAHO.

During 1914 Idaho produced 5,875,205 pounds of blister copper, as compared with 8,711,490 pounds in 1913. The State has made a small and irregular output of copper since 1884, but only since 1903 has it been a steady and important producer. To the close of 1914 it had a recorded output of 80,840,680 pounds.

The Cœur d'Alene district furnished the largest output for 1914 and has been the most productive copper district in the State. Complete figures for the copper output of the district are not on record, but the total production has been approximately 56,724,000 pounds.

The Snowstorm mine is the most important copper producer of the district. This deposit[1] consists of disseminated bornite, chalcocite, and chalcopyrite in certain beds of a pre-Cambrian quartzite; in the upper portion the deposit is oxidized. The lode varies from a few feet to 40 feet in width, and has been developed to a depth of 1,200 feet below the outcrop. Development is by tunnels.

The Alder Creek district was also an important producer.

MICHIGAN.

The production of refined copper in Michigan in 1914 was 158,009,748 pounds, as compared with 155,715,286 pounds in 1913, and with 231,112,228 pounds in 1912. The great reduction in output in 1913 was caused by a strike of miners, which was called July 23, 1913, and continued through the remainder of that year and until April 12, 1914. The continued production on a reduced scale in 1914 was due in part to the labor troubles early in the year and in part to the unfavorable market conditions which followed the outbreak of the European war in August, 1914.

The mining of copper in Michigan antedates the earliest visits of European explorers to the region. The production on a commercial basis, however, dates from 1845, since which time the district has been a steady producer and an important factor in the copper industry of

[1] Ransome, F. L., and Calkins, F. C., The geology and ore deposits of the Cœur d'Alene district, Idaho: U. S. Geol. Survey Prof. Paper 62, pp. 150–152, 1908. Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: U. S. Geol. Survey Bull. 540, pp. 167–211, 1914.

the world. To the close of 1914 Michigan has produced 5,519,442,640 pounds of copper, or 28.59 per cent of the output from the United States since 1845. For many years subsequent to 1845 Michigan was the most important copper-producing State, and in total output it is second only to Montana. The entire output is from the Keweenaw or Lake Superior district.

In the value of metal output, in the profits resulting from this output, in the development of mining and metallurgical processes, and in the general high standing of the companies conducting the operations, the district takes high rank among the great mining camps of the world. Prior to the perfection of the electrolytic process of refining, "Lake" copper enjoyed the distinction of being the highest grade produced, and even to the present time it sells at a figure slightly higher than the copper from other districts.

Although the district has been an active producer for 69 years, most of the older mines still have large reserves of ore and new mines are being opened, while much territory remains to be prospected. Moreover, it is claimed that a large tonnage of the mill tailings produced when milling methods were less efficient than at present can be re-treated at a profit.

Comparatively little new development work was undertaken during 1914 on account of the unfavorable conditions both early and late in the year. Perhaps the most important were the preparations for production of the White Pines Co. in the southern part of the district, which will be a producer in 1915.

The Lake Superior region is unique in being the only district from which a large output is derived from native copper. The rocks [1] of the district comprise a thick series of rather basic lava flows and intercalated beds of conglomerate and sandstone of pre-Cambrian age. These have been tilted so that they have a northwest dip, usually rather steep, and strike in a general northeast-southwest direction. The copper occurs in the cellular portion of the lava flows, which form the amygdaloid lodes, and as a cement and to some extent a replacement of the conglomerate pebbles forming the conglomerate lodes. Copper also occurs in fissures crossing the formations, but at present these are of little commercial importance, though in the early days of the district considerable copper was derived from this type of deposit. A little native silver occurs with the copper. The lodes are of low grade, but characterized by great extent and rather uniform distribution of the metallic content. This, together with the fact that the ore is susceptible of high concentration with low cost of refining the resultant "mineral," makes it possible to work these low-grade deposits at a good profit. The native copper occurs in the lodes in masses varying from microscopic size to bodies weighing hundreds of tons. The richest lode mined at present yields less than 1.5 per cent copper, and the poorest rock treated yields but little above five-tenths of 1 per cent of metal. For this low-grade ore to be profitable it must be handled on a large scale; this has resulted in the construction of the immense plants that characterize the Lake district. The lodes are worked for the most part through inclined

[1] For detailed description of the geology and mining see Irving, R. D., U. S. Geol. Survey Mon. 5, 1883; Michigan Geol. Survey, vols. 5 and 6; Rickard, Eng. and Min. Jour., vol. 88; Pumpelly, Raphael, Michigan Geol. Survey, vol. 1, 1873; Lane, A. C., and Hubbard, L. L., Michigan Geol. Survey, vol. 4, 1898; Rominger, C., Michigan Geol. Survey, vol. 5, 1905; Rice, C. T. Copper Mining at Lake Superior, Eng. and Min. Jour., vol. 94, pp. 119, 171, 217, 307, 365; Hore, R. S., Mineral Resources of Michigan: Mich. Geol. and Biol. Survey, pp. 15–115, 1911; Van Hise, C. R., and Leith, C. K., The Geology of the Lake Superior region: U. S. Geol. Survey Mon. 52, pp. 573–591, 1911.

shafts, though some of the deeper deposits are opened by vertical shafts. The workings have been extended in some cases to a mile in vertical depth, or about a mile and a half down the lode. Pillars of rock are left to keep the lodes open, and dry walls constructed from the waste sorted underground serve the same purpose in some of the mines. Much timber, however, is required in some of the mines, especially those operating on the conglomerate lodes.

The "rock" coming from the mines is crushed by steam stamps and concentrated, producing "mineral" containing an average of about 65 per cent copper. In recent years regrinding plants have been constructed for the finer grinding and concentration of material that had previously been discarded as tailings. The "mineral" is subjected to a combined smelting and refining process. A small amount of "mass" and "barrel work" copper are sorted out at the mine and go direct to the smelter. A portion of the output is refined electrolytically. This consists of copper sufficiently argentiferous to make the recovery of silver profitable, and of copper containing so high a percentage of impurities that further refining is necessary for certain uses. During 1914, 23.6 per cent of the output was refined electrolytically.

Silver in important quantity is recovered only from the copper treated electrolytically. The average recovery per ton of rock from which the copper was refined electrolytically was approximately 0.20 fine ounce.

In the following table is given the production of individual companies compiled from their annual reports, together with the cost of production and the price received for the copper.

The average cost for mines reporting was 10.94 cents a pound. This compares with 13.44 cents in 1913 and with 10.28 cents in 1912.

Production of copper by Michigan mines in 1913 and 1914, in pounds, compiled from the annual reports of the producing companies.[a]

Company.	1913	1914	Cost per pound.	Price received per pound.	Profit (+) or loss (−) 1914.
	Pounds.	*Pounds.*	*Cents.*	*Cents.*	*Cts. per lb.*
Ahmeek	9,220,874	13,634,605	9.71	13.08	+3.37
Allouez	4,091,129	6,056,548	11.18	12.853	+1.673
Atlantic	44,370				
Baltic	7,736,126	7,001,945	11.17	13.38	+2.21
Calumet & Hecla	45,016,890	53,691,562	11.35	14.01	+2.66
Centennial	1,612,262	2,287,130	12.56	12.111	−.449
Champion	12,080,594	15,807,206	9.21	13.38	+4.17
Franklin	1,021,440	93,283		13.99	
Isle Royale	4,158,548	6,601,235	13.05	13.16	+.11
Lake	287,200				
La Salle	43,906	540,731		12.797	
Mass	1,213,545				
Mohawk	5,778,235	11,094,859	8.58	12.47	+3.89
Osceola	11,325,010	14,970,737	10.79	13.14	+2.35
Quincy	12,184,128	15,356,380		13.3	
Superior	2,992,765	3,217,635	12.43	12.645	+.215
Tamarack	4,168,743	1,074,808	29.08	12.80	−16.28
Trimountain	4,990,938	5,048,306	12.21	13.38	+1.17
Victoria	1,428,693	1,486,242			
Winona	1,448,737	1,352,085		14.2	
Wolverine	[b] 8,350,312	[c] 3,435,459	11.72	14.09	+2.37
Average[d]			10.94	13.4	+2.48

[a] As this table includes mines reporting their output both for the calendar and for the fiscal years, and as some of the companies report the refined copper equivalent of mineral produced and others report refined copper, the totals do not necessarily agree with the total of either mine or smelter output.

[b] Figures for fiscal year ending June 30, 1913.

[c] Figures for fiscal year ending June 30, 1914.

[d] Average includes only mines whose reports are for the calendar year.

The average copper yield per ton of "rock" milled during 1914 was 17.7 pounds, as compared with 19.4 pounds in 1913. During 1914 the rock milled amounted to 9,269,413 tons, as compared with 7,016,370 tons in 1913.

The change in grade of ore handled by the Lake companies is shown in the following table. The figures are compiled from the annual reports of the companies.

Quantity of ore milled and copper derived therefrom by Michigan copper companies in 1913 and 1914, compiled from the annual reports of the producing companies.

Company.	1913		1914	
	Quantity.	Yield per ton.	Quantity.	Yield per ton.
	Short tons.	*Pounds.*	*Short tons.*	*Pounds.*
Ahmeek	383,749	24.0	590,519	23.1
Allouez	236,663	17.29	354,457	17.09
Baltic	333,289	23.21	324,433	21.58
Calumet & Hecla	2,035,625	22.11	2,592,462	20.70
Centennial	85,443	18.87	138,136	16.56
Champion	421,849	28.64	614,854	25.71
Franklin	123,179	8.29	7,324	12.73
Isle Royale	314,679	13.2	474,349	13.9
Lake	19,211	14.95	.....	.....
La Salle	2,221	19.76	45,509	11.88
Mass	78,250	15.51	.....	.....
Mohawk	366,458	15.76	649,649	17.08
Osceola	735,044	15.4	1,108,447	13.5
Quincy	.....	.....	.....	.....
Superior	130,826	22.87	191,628	16.79
Tamarack	227,563	18.3	57,410	18.7
Trimountain	229,149	21.78	277,251	18.21
Victoria	137,163	10.42	124,842	11.9
Winona	120,806	11.99	123,339	10.96
Wolverine	.....	.....	[a]182,127	[a]18.86

[a] Figures for fiscal year ending June 30, 1914.

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, the Lake transportation being brought into the heart of the district by Portage Lake and the Houghton ship canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central railroads and is connected with the main lines of traffic by the Chicago, Milwaukee & St. Paul and Duluth, South Shore, & Atlantic railways.

MONTANA.

The output of blister copper from Montana in 1914 was 236,805,845 pounds, as compared with 285,719,918 pounds in 1913. The State ranked second in production of copper in 1914.

The first record of production of copper from Montana is for 1868, but the State did not become an important contributor of this metal until 1880. Since that time there has been a steady and rapid increase in the copper output. To the close of 1914 the State has produced 6,429,550,473 pounds, or 32.14 per cent of the total output of the United States since 1845. In total production the State ranks first, and in the output for 1914 it ranked second. The Butte district has furnished nearly the entire output.

Three copper-smelting plants were operated in Montana in 1914: The smelter of the East Butte Mining Co., at Butte, and the smelters of the Anaconda Copper Co., at Anaconda and at Great Falls.

Butte district.—In 1914 the Butte district, Silver Bow County, produced about 235,700,000 pounds of copper, or about 20.47 per cent of the total output of the country.

The presence of copper minerals in the district has been known since the discovery of gold in 1864, and attempts were made to treat the ores as early as 1866; but it was not until the late seventies that Butte began to attract attention as a copper camp, and large production did not begin until a railroad reached the district in 1881. To the close of 1914 Butte has produced about 6,413,500,000 pounds of copper, or 32.05 per cent of the total output of the country since 1845. In total production and in the output for 1914 it ranks first among the copper-producing districts of the United States.

The copper ores [1] of the district occur as replacement veins in a granitic rock known technically as quartz monzonite. These veins form complex systems of slightly different ages.

The principal original ore minerals in the copper veins are pyrite, enargite, bornite, chalcocite,[2] chalcopyrite, with varying quantities of sphalerite. It had been generally considered that the commercial ore has resulted from the processes of enrichment and that the material produced by the original mineralization was too low in copper content to be of commercial importance; but more recently many geologists have considered that all the ore minerals in the deeper levels are of primary origin—that is, that they were deposited from ascending solutions and that only the upper part of the deposit has been extensively effected by changes resulting from descending solutions.

The grade of ore mined in the district is regulated to a considerable degree by the possibility of profitable treatment. An increase in the price of copper or a decrease in the cost of mining and treatment permits the mining of lower grade ores. In 1914 the average yield was 2.66 per cent copper, as compared with 2.70 per cent in 1913 and with 3.02 per cent in 1912. In 1914 smelting ores averaging 4.97 per cent copper furnished about 28 per cent of the output derived from ores, and concentrating ores averaging 2.04 per cent furnished about 72 per cent. The ores averaged 1.83 ounce silver and 0.059 ounce gold per ton, the precious metal content reducing the cost of copper about 2.13 cents a pound.

During the latter part of the year the Great Falls plant of the Anaconda Co. was closed and there was considerable curtailment at the Washoe plant. The smelter of the East Butte Co. was also closed.

Development work in the mines of the Anaconda Co. during the year amounted to 33.15 miles and a tonnage of ore slightly in excess of that extracted was added to the reserves.

The mines of the company produced during the year 3,898,100 tons of ore and 6,782 tons of precipitate, or a total of 3,904,882 tons.

The reduction works treated for all companies during the year 3,748,726.49 tons of ore and other cupriferous material at Anaconda, and 488,243.73 tons of ore and other

[1] Weed, W. H., Geology and ore deposits of the Butte district, Montana: U. S. Geol. Survey Prof. Paper 74, 1912; Kirk, C. T., Conditions of mineralization in the copper veins of Butte, Mont.: Econ. Geology, vol. 7, p. 35; Sales, Reno H., Ore deposits at Butte, Mont.: Am. Inst. Min. Eng. Bull., August, 1913: Bard, D. C., and Gidel, M. H., Mineral associations at Butte, Mont.: Am. Inst. Min. Eng. Bull., August, 1913; Dunshee, B. H., Timbering at Butte, Mont.; Am. Inst. Min. Eng. Bull., August, 1913; Ingalls, R. W., Recent observations in Butte and Anaconda: Eng. and Min. Jour., vol. 97, pp. 937–943, 1914; Ray, J. C., Paragenesis of the ore minerals in the Butte district, Mont.: Econ. Geology, vol. 9, pp. 463–491; Liest, Frederick, Improvements at Anaconda Reduction Works: Min. World, vol. 42, p. 367, 1915; Mathewson, E. P., New Anaconda leaching and acid plants: Min. Jour., vol. 99, pp. 723–727, 1915.

[2] Sales, R. H., Econ. Geology, vol. 5, p. 681, 1910; Graton, L. C., and Murdoch, Joseph, The sulphide ores of copper: Am. Inst. Min. Eng. Bull. 77, 767, May, 1913.

cupriferous materials at Great Falls. Of this 3,768,640.01 tons of ore from company mines, 467,903.97 tons of ore purchased from or treated for other companies, and 426.24 tons of precipitates and cleanings from the old works were treated, from which there was produced 188,664,551 pounds of fine copper, 7,555,915.11 ounces of silver, and 78.815.428 ounces of gold at Anaconda; and 35,055,741 pounds of fine copper, 758 200.54 ounces of silver, and 20,835.558 ounces of gold at Great Falls; or a total production of 223,720,292 pounds of fine copper, 8,314,115.65 ounces of silver and 99,650.986 ounces of gold; of which amount 205,298,531 pounds of fine copper, 7,221,815.31 ounces of silver, and 99,650.986 ounces of gold were produced by your company.

The round table plant was completed early in the year and put into operation with gratifying success both as to recovery and as to copper content of concentrates produced.

Construction of the 2,000-ton leaching plant to treat tailings was in progress, as was also that of a 100-ton acid plant, which will furnish acid for leaching operations. The tests of firing reverberatory furnaces with coal dust proved so successful that it is planned to remodel the entire reverberatory plant for operation with pulverized coal as fuel.

Tests of concentration by a flotation process proved also so successful that the company will change the entire plan of the concentrator to introduce this method and will increase its capacity from 12,500 to 15,000 tons. It is expected that the improvements when completed will effect a saving of over 90 per cent of the copper content of ores treated as compared with 78 per cent at present.

At Great Falls it is proposed to build a new electrolytic refinery having a capacity of 10,000,000 pounds of copper per month to replace the present plant with a capacity of 5,000,000 pounds per month. At Great Falls furnaces fired by coal dust will be used to treat concentrates from the Anaconda mills.

Profits of the company for the year amounted to $8,789,587.63. Dividends were paid to the amount of $9,077,500.

The East Butte Co. carried on active operations for the first seven months of the year, producing 72,853 tons of ore (wet weight) having an average assay content of 4.72 per cent copper. There was treated at the smelter 110,992 tons of ore yielding 9,175,579 pounds of copper, 242,347 ounces of silver, and 2,219 ounces of gold. The average cost of producing copper was 11.11 cents per pound. The net surplus of operations for the year was $222,252.84.

During 1914 there was produced by the mines of the North Butte Co. 343,314 wet tons of ore and 71 wet tons of precipitate. There was treated at the smelter 337,372 dry tons of ore and 43 dry tons of precipitate, of which 60,527 tons, or 18 per cent, was first class and 276,845 tons, or 82 per cent, was second class. This ore produced 18,421,761 pounds of fine copper, 1,092,300 ounces of silver, and 1,107 ounces of gold. The net income for the year amounted to $358,215.02. Dividends were paid to the amount of $635,000.

The mine of the Tuolumne Copper Co. was operated till October 24, when it was closed on account of the unfavorable market conditions. The production during the period consisted of 1,945,286 pounds of copper, 115,355 ounces silver, and 150 ounces gold. The average copper content of ore was 4.10 per cent.

The Pilot Butte Mining Co. became a producer during the year, with an output of 368,261 pounds of copper, 19,083 ounces silver, and 27 ounces gold. The average copper content of the ore shipped was 4.936 per cent.

NEVADA.

The production of blister copper in Nevada in 1914 was 60,122,904 pounds, as compared with 85,209,536 pounds in 1913.

The earliest record of the production of copper in Nevada was for 1873, but the State did not become an important factor in the copper industry until 1908, when production from the Ely district began. To the close of 1914 Nevada has a recorded production of 432,246,452 pounds, or 2.16 per cent of the output of the country since 1845. To this should probably be added a small but unknown quantity of copper produced as bluestone in the early days of mining in the State and used locally in the treatment of gold and silver ores. In total production and in the output for 1914, Nevada ranks sixth among the copper-producing States.

A large part of the output was from two districts, the Ely district, in White Pine County, and the Yerington district, in Lyon County.

Ely district.—The Ely district, White Pine County, was the largest producing district in Nevada in 1914. Although it has long been known that the district contained copper deposits, active development on an important scale began only a few years ago, and important production did not begin until 1908, when the Steptoe Valley smelter and concentrating plant was completed.

During 1914 the district produced about 50,542,000 pounds of blister copper, and to the close of 1914 the output has been about 376,442,000 pounds. The district has yielded 1.88 per cent of the total output of the country since 1845, and it produced 4.39 per cent of the output in 1914. In total production it ranks ninth and in the production for 1914 eighth among the copper districts of the country.

The district is in the Egan Range, the geology [1] of which may be summarized as follows: Paleozoic limestones and shales have been invaded by a granite intrusive technically known as quartz monzonite porphyry, probably of Mesozoic age. Later the area was buried beneath lava flows which have been in large part removed by erosion.

The copper ores are of two types, replacement deposits in the limestone, and disseminated deposits in the altered monzonite porphyry. The deposits in the limestone are near the quartz monzonite and are associated with garnet and other contact silicates and usually with abundant jasperoid. The deposits of this type thus far developed have been largely oxidized and to the present time there has been a relatively small production from them.

The disseminated ores are principally included in the monzonite porphyry area though they extend into the adjacent sediments to some extent. The monzonite porphyry has been much shattered and altered, the hornblende and feldspars of the monzonite being altered to orthoclase, quartz, sericite, and brown mica. The metallic minerals of the primary ore, pyrite and chalcopyrite, occur as veinlets and disseminated grains in the altered rock. The commercial ore has resulted from the process of enrichment. In this enrichment the copper in the upper part of the deposit has been in part taken into solution and redeposited on the sulphides lower in the deposit, usually as chalcocite. The commercial ore consists of grains of pyrite and chalcopyrite partly or entirely replaced by chalcocite.

[1] Lawson, A. C., California Univ. Dept. Geology Bull. 4, p. 284; Spencer, A. C., U. S. Geol. Survey Bull. 529, p. 189, 1913.

The leached capping is of varying thickness, but for a part of the deposit it is thin enough to permit of its removal and of the mining of the ores by steam shovel; for the remainder underground methods of mining are necessary.

For the Eureka section of the Nevada Consolidated Copper Co.'s area the average thickness of the capping is 87.1 feet, and of the profitable ore 190 feet; for the Hecla area the capping is of an average thickness of 101.4 feet and the ore is 280.3 feet thick; and for the Liberty area the capping is 154.7 feet thick and the ore 193.3 feet thick.

During the year the Nevada Consolidated Copper Co. developed 7,347,600 tons of ore having an average copper content of 1.69 per cent.

The profitable ore in reserve December 31, 1914, is estimated as 41,020,296 tons, having an average copper content of 1.68 per cent.

During the year the following tonnage of sulphide ore was mined and shipped to the concentrator:

Copper ore mined and shipped by Nevada Consolidated Copper Co. in 1914, in short tons.

	Quantity.	Per cent of copper.
Eureka pit	578,981	1.405
Liberty-Hecla pits	1,934,260	1.405
Veteran	123,324	3.063
Total	2,636,565	1.483

Siliceous carbonate ores amounting to 14,498 dry tons and averaging 2.51 per cent copper were mined, all of which were crushed and delivered to the smelter.

The following table shows the results of operations of the concentrator:

Operations of Nevada Consolidated Copper Co. concentrator for the year ending Dec. 31, 1914.

Ore treated (dry)	short tons	2,640,294
Average copper assay	per cent	1.483
Percentage of extraction (copper)	do	68.48
Ratio of concentration		6.05
Average value in gold	ounces	.013
Average value in silver	do	.031
Percentage of extraction (gold)	per cent	46.75
Percentage of extraction (silver)	do	60.76
Average gold and silver recovered per ton of ore	cents	13.45
Average copper in concentrates	per cent	6.145

The output of copper for the year 1914 from all ores mined and treated and from siliceous carbonate ores delivered to the smelter amounted to 49,244,056 pounds. The total cost per pound of copper was 9.82 cents.

The net profit of the year was $1,763,020.58. Dividends were paid to the amount of $2,249,389.11.

In May, 1913 the Consolidated Coppermines Co. was formed as a consolidation of several properties, including the old Coppermines Co., the Giroux, the Butte & Ely, and New Ely Central companies.

From June 1, 1913, to April 30, 1914, the Giroux Co. mined and shipped 170,298 wet tons of ore, and during the same period produced 3,041,678 pounds of copper, 2,212 ounces silver, and 1,061 ounces gold. The general manager, under date of June 1, 1914, estimates the following ore reserves:

Giroux.—Fully developed 14,199,180 tons averaging 1.219 per cent copper. Partly developed 6,456,872 tons, averaging 1.041 per cent copper.

Old coppermines.—Partly developed 968,184 tons, averaging 1.01 per cent copper.

Total developed and partly developed 21,624,236 tons, averaging 1.153 per cent copper.

Yerington district.—The Yerington district produced 7,480,000 pounds of blister copper in 1914.

Copper ores have been mined in the district for many years. In the early days considerable natural bluestone was mined and used in the treatment of gold ores at Virginia City. Later an attempt was made to smelt the ores, but with little success. No accurate data of the total output of the district has been compiled, though it has not been large. During the last few years development of ore by several companies has been in progress, and it is reported that considerable ore carrying copper values of 3 per cent or better have been opened.

The ores of the district according to Ransome [1] are of three types of occurrence:

(1) Irregular bodies formed by metasomatic replacement of limestone and genetically associated with metamorphism of a kind usually attributed to contact action of intrusive rocks; (2) metasomatic vein deposits in altered limestone; and (3) metasomatic vein deposits in granodiorite.

The most important developments are of ore bodies of the first type. The original sulphides of these are pyrite and chalcopyrite in various proportions. with a gangue of pyroxene, amphibole, epidote, garnet, and calcite.

The smelter of the Mason Valley Mines Co., Wabuska, was operated till October 20. There were treated 142,197 tons of ore, of which 75,038 tons were from the mines of the company and 67,159 tons were custom ore. From these ores copper matte and blister was produced containing 9,127,971 pounds of copper, 11,553 ounces of gold, and 221,151 ounces of silver.

The Nevada-Douglas Copper Co. has under construction a leaching plant for the treatment of its ores.

Other districts.—Other districts in Nevada producing copper in 1914 were Goldfield, Pioche, and Santa Fe.

NEW MEXICO.

The production of blister copper from New Mexico in 1914 was 69,204,703 pounds, as compared with 50,196,881 pounds in 1913. The increase was due to the larger production by the Chino Copper Co., of the Santa Rita district.

Production of copper from New Mexico began in the last years of the eighteenth century, native copper from the mines of Grant County being carried to Mexico City and coined into money. During the nineteenth century, however, there was but small output. A little copper is reported for about the year 1860, but New Mexico did not have a steady output until after 1880 and did not become an important factor in production until 1900.

[1] Ransome, F. L., The Yerington district, Nevada; U. S. Geol. Survey Bull. 380, p. 99, 1909.

From 1845 to 1914 New Mexico has a recorded output of 238,755,547 pounds of copper, or 1.19 per cent of the output of the country since 1845. The principal production has been from the districts in Grant County.

Santa Rita district.—The Santa Rita district was probably the first district in the West in which there was important production of copper; the output began in the closing years of the eighteenth century and the metal went to Mexico for coinage. There are no accurate records of the production for this early period of operation, but from the best sources available it is estimated that the total production to the close of 1914 has been approximately 233,900,000 pounds.

The geology [1] of the district is rather complex. The sedimentary series, consisting of quartzite, shales, and limestones, has been invaded in post-Cretaceous time by granitic and porphyritic rocks of monzonitic and dioritic composition. After a period of erosion the area was buried beneath Tertiary volcanic flows, which in turn have been largely removed by erosion.

The copper deposits may be divided into two types—contact deposits and disseminated deposits. The contact deposits occur as replacement of limestone near the porphyry contact and have been most extensively worked in the Hanover end of the district.

In the disseminated deposits the ore minerals occur as small veins and grains in shattered and highly altered sedimentary and intrusive rocks. Unlike many of the disseminated deposits, much of the copper occurs native and as the oxide, though chalcocite ores are also abundant. Prior to 1912 the main production came from shallow workings, following high-grade streaks of native copper, and from oxide and chalcocite ores.

Since 1909 the Chino Copper Co. has been actively developing the main mineralized area by means of churn drills, and production by this company began late in 1911. The management reported the developed ore at the close of 1914 as more than 90,000,000 tons, of an average grade of about 1.75 per cent copper.

It is stated that nearly 90 per cent of the developed ore can be extracted by steam-shovel methods, and a part of the area has already been stripped and is being mined by this method.

During the year 1,907,300 tons of ore were treated at the mill. The average copper content of the ore was 2.1151 per cent and the average recovery of copper contained in concentrates was 67.858 per cent of the copper contained in the ore.

The amount of gold paid for by the smelter amounted to 2.71 cents per ton of ore, or 0.1 cent per pound of copper.

The total production for the year of copper in concentrates was 54,748,254 pounds, the average grade of concentrates being 18.505 per cent copper and the ratio of concentrates 12.89 tons into 1. The increase in the grade of the concentrates over that of 1913 was due to the operation of the concentrate cleaning plant, in which a flotation method is employed.

In addition to concentrates, direct shipping ores having a copper content of 2,093,723 pounds were produced; they brought the total output up to 56,841,944 pounds in ore and concentrates. Deducting

[1] Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, p. 305, 1910; Paige, Sidney, The geologic and structural relations at Santa Rita (Chino), N. Mex.: Econ. Geology, vol. 7, p. 547.

losses for further treatment, the net production of copper was 53,999,928 pounds. The average cost of producing copper for the year was 7.68 cents per pound.

Profits of the company for the year were $3,222,579.10. Dividends were paid during the year to the amount of $2,169,065.

Ore and concentrates are treated at the El Paso and Hayden smelters. The district is served by a branch line of the Santa Fe Railway, which connects with the main line and with the Southern Pacific at Deming.

Burro Mountain district.—The Burro Mountain district, southwest of Silver City, made only a small production in 1914. The total production from the district has probably been about 10,000,000 pounds of copper.

The Burro Mountain [1] consists of a pre-Cambrian complex that has been intruded by monzonite porphyry. The copper ores occur mainly as impregnations and replacements along irregular fractures and zones of crushing. The primary sulphide is cupriferous pyrite, but the workable deposits have resulted from the enrichment of the primary ores.

The operations of the Burro Mountain Copper Co., controlled by Phelps, Dodge & Co., were confined principally to preparations for extraction and milling of ore. A 1,000-ton concentrator was in process of construction, which will probably be in operation by the close of 1915.

The Lordsburg district was the only other important contributor to the copper production of the State.

TENNESSEE.

The production of blister copper in Tennessee in 1914 was 18,661,112 pounds, as compared with 19,489,654 pounds in 1913.

The entire output was from the Ducktown district, located in the extreme southeastern part of the State, in Polk County. The district was one of the earliest large producers in the country. Operations began about 1850, and from that date till the close of the Civil War there was a large production from the "black-copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper & Iron Co. began operations. Since that time the district has been a steady producer from the primary sulphide ores. To the close of 1914 the total output of the district has been approximately 287,205,000 pounds.

The ores [2] occur as steeply dipping lenses replacing calcareous strata in schist, the ore bodies in general conforming to the dip and

[1] Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, p. 321, 1910. Paige, Sidney, Metalliferous ore deposits near the Burro Mountains, Grant County, N. Mex.: U. S. Geol. Survey Bull. 470, p. 131, 1911. Somers, R. E., Geology of the Burro Mountains copper district, N. Mex.: Am. Inst. Min. Eng. Bull. 101, pp. 958–996, 1915.

[2] The deposits have been described by Heinrich, Carl, Am. Inst. Min. Eng. Trans., vol. 25, p. 173; Weed, W. H., idem, vol. 30, p. 452; Kemp, J. F., idem, vol. 31, p. 224; Higgins, E., Eng. and Min. Jour., vol. 86, pp. 1237–1241, 1908; Channing, J. P., Min. and Sci. Press, vol. 96, p. 97, 1908; Gottsberger, B. B., Mining World, vol. 29, pp. 911–914, 1908; Weed, W. H., Ore deposits of the Appalachian States: U. S. Geol. Survey Bull. 455, p. 152, 1911; Laney, F. B., The manufacture of sulphuric acid from smelter fumes at Ducktown, Tenn.: U. S. Geol. Survey Mineral Resources, 1911, pt. 2, 1912; Emmons, W. H., and Laney, F. B., Preliminary report on the mineral deposits of Ducktown, Tenn.: U. S. Geol. Survey Bull. 470, pp. 151–152, 1911.

strike of the schistosity of the inclosing rock. The principal sulphide is pyrrhotite, with subordinate pyrite, chalcopyrite, and sphalerite. Extensive gossans capped the ore bodies, and it was the enriched zones underlying these that furnished the rich chalcocite ores that were extracted during the first period of activity.

In 1914 the ores of the district yielded 28.7 pounds of blister copper per ton, or 1.435 per cent, with an average value of 9 cents in gold and silver per ton of ore. A part of the copper is marketed without electrolytic refining. The fact that the ores can be extracted with little timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor have made it possible to mine and treat these low-grade ores at a profit.

The pyritic process of smelting is practiced successfully by both companies. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

Sulphuric-acid plants were operated by both the Ducktown Sulphur, Copper & Iron Co. and the Tennessee Copper Co. The successful operation of these plants has apparently not only solved the troublesome smelter-smoke problem, but added very materially to the revenue of the companies. The sulphuric-acid production will probably be fully as important in the future as the copper output.

The Tennessee Copper Co. produced 468,668 tons of ore during the year, and the reserves at the close of 1914 in the Burra Burra, London, and Polk County mines were estimated at 4,010,661 tons. From the 485,051 tons of ore of the Tennessee Copper Co. were produced 12,871,113 pounds of copper at a cost of 10.381 cents per pound at the mines. The cost of refined copper was 11.4 cents per pound.

Net profits for the year were $751,892.97. Dividends were paid to the amount of $600,000.

During the year ending December 31, 1914, the production of copper by the Ducktown Sulphur, Copper & Iron Co. was 5,862,000 pounds from 169,000 tons of ore, as compared with 5,992,000 pounds from 182,000 tons in 1913. The 60 per cent sulphuric acid manufactured amounted to 45,770 tons, as compared with 48,851 tons in 1913.

The company estimates that ore reserves at the Mary mine amount to about 700,000 tons, averaging about 2 per cent copper and 15 per cent sulphur. The East Tennessee mine is reported as capable of producing 40,000 tons of ore, averaging in excess of 2½ per cent copper and 8 per cent sulphur. The Isabella mine has reserves of 2,500,000 tons, averaging 29 per cent sulphur and 0.8 per cent copper.

The district is served by a branch line of the Louisville & Nashville Railroad, with which the mines and smelters of the companies are connected by private line.

UTAH.

In 1914 Utah produced 160,589,660 pounds of blister copper, as compared with 148,057,450 pounds in 1913. The mine production for the period was considerably less than the smelter production, owing to the curtailment in mine production the latter half of the year when smelter stocks were lowered.

The first record of production of copper from Utah is for 1872. The State did not become an important copper producer, however, until late in the nineties, since which time the growth of the industry

has been steady and rapid. The total recorded output from the State to the close of 1914 has been 1,241,911,837 pounds, 6.21 per cent of the output of the United States since 1845. In 1914 Utah produced 13.96 per cent of the output. In total output it ranks fourth and in the production for 1914 it ranks third among the copper-producing States.

Two copper-smelting plants were operated in the State during 1914, the Garfield smelter at Garfield, and the International smelter at Tooele.

Bingham district.—The Bingham or West Mountain district, Salt Lake County, produced about 150,000,000 pounds of blister copper in 1914, as compared with about 132,000,000 pounds in 1913. As already noted, the smelter production for the year was considerably in excess of the mine production, which was about 144,000,000 pounds.

The presence of copper minerals has been known since the early days of mining in the district, but for many years operations were confined to the production of lead, silver, and gold. Not until 1896 did the mining of copper ore become of large commercial importance. To the close of 1914 the district has produced approximately 984,500,000 pounds, or 4.92 per cent of the output of the country since 1845. For 1914 the district yielded 13.04 per cent of the total production.

In total output the district ranks fifth among those of the country and in the production for 1913 it ranks fourth.

The ore deposits of the district [1] are closely associated with masses of monzonite porphyry intruded into a series of quartzites with intercalated beds of limestone and shale of Carboniferous age. The copper ores are of two types of occurrence—as irregular replacement deposits of limestone, and as disseminated deposits through altered porphyry and quartzite.

In the early years of production most of the copper from the district was derived from the replacement deposits in limestone. These are massive bodies of pyrite carrying chalcopyrite in varying quantity and in places grading into ores carrying galena and sphalerite in important quantity. They occur as replacements of the limestone associated with fissures and usually not far from bodies of monzonite porphyry. Enrichment has not extended to great depth in this type of deposit and the enriched ores have been largely extracted. The ores vary greatly in copper content and consequently the average percentage derived for a given year depends largely on the grade that can be worked at a profit at the price of copper. In 1914 the ores yielded about 1.75 per cent copper and rather high values in gold and silver. About 408,000 tons of this type of ore were produced during the year, yielding about 14,230,000 pounds of copper.

The primary mineralization of the disseminated type of ore consists of grains and veinlets of pyrite and chalcopyrite disseminated through shattered and altered monzonite porphyry and quartzite. The varying intensity of alteration of the monzonite porphyry has yielded different gangue minerals in different parts of the disseminated ore body, forming what is designated as "dark porphyry" and "light porphyry."

[1] For detailed information see Boutwell, J. M., Economic geology of the Bingham mining district, Utah: U. S. Geol. Survey Prof. Paper 38, 1905.

In the "dark porphyry," the hornblende and augite of the monzonite have been altered to brown mica, while the plagioclase feldspar has been altered in part to sericite and in part to secondary orthoclase. The abundant brown mica gives the rock a dark color. In the "light porphyry" the lime and magnesia have been largely removed and there has been a marked addition of potassium resulting in a rock composed essentially of quartz, secondary orthoclase, and sericite together with the metallic sulphides.

The commercial ore is the result of enrichment, the copper content of the upper portion of the deposit having been in part taken into solution and redeposited on the sulphides at greater depth. These secondary sulphides include both covellite and chalcocite. As contrasted with many similar deposits covellite is relatively abundant as a secondary sulphide. Secondary sulphides are relatively less abundant in the Bingham disseminated ores than in several similar deposits. The commercial ore body is an irregular layer covered by the leached and partly leached "capping" and underlain by the lean primary ore. The average thickness of the commercial ore, as shown by the developments of the Utah Copper Co. to the close of 1914, is 165 feet. The thickness of the "capping" varies greatly at different points. As determined at the close of 1914, the average thickness over the entire ore body is 115 feet. The disseminated ores are extracted by both steam-shovel and underground methods. Underground methods have, however, been practically discontinued. During the year about 7,047,000 tons of disseminated ore was mined in the district, which yielded about 0.88 per cent of copper in concentrates and small values per ton in gold and silver.

The ores were treated at the mills at Garfield and at the Ohio Copper Co.'s mill at Lark. The ores and concentrates from the district were reduced at the Garfield smelter and the International smelter.

The mills of the Utah Copper Co. treated 6,470,166 tons of ore, having an average copper content of 1.425 per cent. The average recovery was 66.04 per cent, equivalent to 18.82 pounds of copper per ton of ore treated. The total production in concentrates for the year by the Utah Copper Co. was 121,779,401 pounds, or, after making deduction for loss in smelting, a net production equivalent to 115,690,445 pounds of refined copper. In addition to the copper there were produced 34,729 ounces of gold and 325,351 ounces of silver. The average cost of producing this copper was 8.131 cents per pound. At the close of 1914 development had been carried on over an area of 226.3 acres, and ore estimated at 377,690,400 tons, having an average copper content of 1.453 per cent, had been developed and partly developed. Of this ore 35,190,400 tons, having an average copper content of 1.457 per cent, had been extracted prior to January 1, 1915, leaving ore reserves at that date of 342,500,000 tons, averaging 1.45 per cent copper. The combined capacity of the company's mills at Garfield is 21,000 tons a day of average ore, but when operating on low-grade ore they have treated at the rate of 24,000 tons a day.

Operations were carried on at the mine and mill of the Ohio Copper Co. for only part of the year.

The Utah Consolidated Mining Co. shipped 153,345 tons of copper ore, averaging 2.509 per cent copper, 0.085 ounce of gold, and 0.996

ounce of silver per ton. At the close of the year there was reported as in sight in the mine 256,521 tons of copper ore, averaging 1.90 per cent copper and 0.054 ounce of gold and 0.697 ounce of silver per ton. The ores were shipped over the aerial tram to the International smelter.

Several other companies in the district were important producers of copper and copper-lead ores, notably the Old Jordan mine of the United States Mining Co., the Yampa mine, and the Bingham-New Haven mine.

The district is served by a branch of the Denver & Rio Grande Railroad and the Bingham & Garfield Railway, controlled by Utah Copper Co. interests, which connects the mines at Bingham with the mills at Garfield. Cable tramways are employed to considerable extent; the ores from the Utah Consolidated mines are delivered to the International smelter in this manner, and ores from other mines are delivered to the railroad over cable tramways.

Tintic district.—The Tintic district in Juab County produced about 6,000,000 pounds of blister copper in 1914, as compared with about 9,250,000 pounds in 1913. The production of copper from the Tintic district is largely incidental to the production of other metals. The quantity of ore in which copper is the most important metal constituent is relatively small. There has been a small output of copper from the district for many years, but no accurate statistics of the early output are available. It is estimated that to the close of 1914 the district has yielded approximately 119,150,000 pounds of copper.

The occurrence of ores [1] may be briefly summarized as follows:

The sedimentary series, consisting of limestone and quartzite, has been intruded by an extensive mass of monzonite. The ores occur as replacement deposits in the limestone near the monzonite contact, as replacement veins in the igneous rocks, and as replacement veins in the sedimentary series.

The most valuable deposits developed are of the last-named type. The fissures are usually nearly vertical, and the replacement bodies are extremely irregular in form and variable in size. The original minerals were pyrite, galena, sphalerite, and enargite, with rich silver and gold minerals in a gangue of quartz and barite.

There has been little development below the water level, which is usually below 1,600 feet in the deposits in limestone, and oxidation to this point has been rather complete. Recent developments below the water level in some of the mines have been encouraging.

The Centennial-Eureka mine was the most important producer of copper in 1914, as in previous years, though important production was made by the Gold Chain, Iron Blossom, Mammoth, Opohongo, and a smaller production by other mines.

Beaver County.—Beaver County produced about 1,500,000 pounds of copper in 1914, as compared with 3,000,000 pounds in 1913.

The first important production of copper from this district was from the Horn Silver mine in 1889, and since that time there has been a production of copper from lead-silver ores and from small copper mines. The importance of the district as a copper camp dates from the starting of the mill in 1905 to treat ores of the Cactus mine. To the close of 1914 the district has yielded approximately 40,100,000 pounds of copper.

[1] For detailed report, see Tower, G. W., and Smith, G. O., U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, pp. 601–767, 1899.

During 1914, as in previous years, the Cactus mine was the largest producer of copper, but important production was made by the Horn Silver mine, and other mines in the county contributed also to the copper output.

The ores [1] of the area are of several types. Those of the Cactus mine consist of pyrite and chalcopyrite, disseminated in a highly brecciated and altered area of quartz monzonite. Most of the ore is of low grade and requires concentration before shipping. The company's 1,000-ton mill was operated only part of the year. Concentrates were shipped to the International smelter for treatment. Other mines in the area made smaller outputs of copper from copper and mixed ores.

Other districts of the State that contributed in important degree to the copper output were the Lucien, Ophir, Rush Valley, Park City, Snake Creek, and Little Cottonwood districts.

OTHER STATES.

Missouri.—Missouri produced 53,519 pounds of copper in 1914, as compared with 576,204 pounds in 1913. The copper is mainly recovered as a by-product in the dressing of lead ores.

Oregon.—Oregon produced 5,599 pounds of copper in 1914, as compared with 77,812 pounds in 1913. To the close of 1914 the State has a recorded output of 2,970,998 pounds. The largest production in recent years has been from the Waldo district in Grant County.

Pennsylvania.—Pennsylvania produced 422,741 pounds of blister copper in 1914, as compared with 245,337 pounds in 1913. The copper is recovered as a by-product in the treatment of pyritiferous magnetite at the Cornwall mines, Lebanon County.

Virginia.—Virginia produced 17,753 pounds of copper in 1914.

Washington.—Washington produced 683,602 pounds of blister copper in 1914, as compared with 732,742 pounds in 1913. The State contains no important producing district, the total recorded output to the close of 1914 being only 4,659,566 pounds. The Tacoma smelter was operated principally on ores from outside the State.

REFINERY PRODUCTION.

The refinery output of the United States was made by 13 plants, 9 of which employed the electrolytic method and 5 employ the furnace process on Lake Superior copper, the Calumet & Hecla plant employing both the electrolytic and the furnace refining method. Six of the large electrolytic refineries are located on the Atlantic tidewater, and 5 Lake refineries are on the Great Lakes. Only 2 plants are located west of the Great Lakes—1 at Great Falls, Mont., and 1 at Tacoma, Wash. In addition to these refineries, there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper. The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

CASTING AND PIG COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and

[1] For detailed description of the ore deposits, see Butler, B. S., Geology and ore deposits of the San Francisco and adjacent districts, Utah: U. S. Geol. Survey Prof. Paper 80, 1913.

ordinarily cast into ingots. This copper is usually unfit for the uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries such low values in precious metals that, together with the value added to the copper by electrolytic refining, these values will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals is exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the casting copper, shown in the table, is from the Morenci-Metcalf district, Arizona. The pig copper is from this district and the Ducktown, Tenn., district Both districts produce a rather high grade of blister carrying low values in precious metals, and it is found profitable to market much of that from the Morenci district without electrolytic refining. During 1914 the production of new casting copper amounted to 21,506,325 pounds and of pig copper to 39,334,043 pounds.

LAKE COPPER.

By Lake copper, as the term is used in this report, is meant the output of the Lake smelters. A considerable portion of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or is sold as some brand of Lake copper. Of the 158,009,748 pounds of copper produced by the Lake smelters, about 37,430,000 pounds were refined electrolytically, either to free the copper from impurities or to recover the silver content.

ELECTROLYTIC COPPER.

Under electrolytic copper, as shown in the accompanying table, is included all new copper that was refined electrolytically, except that from the Lake district. In 1914 the production of electrolytic copper from primary materials of domestic origin amounted to approximately 991,573,073 [1] pounds and from materials of foreign origin to 323,358,205 pounds. Electrolytic copper to the amount of 27,702,928 pounds was produced from secondary sources, making a total electrolytic production of 1,342,634,206 pounds for the year.

SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A careful canvas of plants producng secondary copper has been made by J. P. Dunlop, of the United States Geological Survey. Concerning the output of secondary copper Mr. Dunlop states:

> The total quantity of secondary copper recovered in 1914, on the assumption that the brass remelted had an average copper content of 70 per cent, was 127,882 tons, of which 15,964 tons (about 2,700 tons less than in 1913) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 36,658 tons of pig copper, 5,934 tons of copper in alloys other than brass, and 69,326 tons of copper in remelted

[1] The separation of refined copper into copper of foreign and domestic origin is only approximate.

brass. These figures indicate a decrease for 1914 of about 2,700 tons of pig copper and 50 tons of copper in brass and a decrease of about 5,600 tons in alloys other than brass. At least 40,000 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only about 77,800 tons was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. The value of the copper, both as metal and in alloys, is computed at the average yearly price quoted for casting copper by the American Metal Market. According to the Bureau of Foreign and Domestic Commerce, the exports of scrap brass, fit only for remanufacture, for the calendar year 1914 were 10,420 tons, and the imports were 2,565 tons. Many railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports received show that the railways utilized in their own shops and foundries over 12,069 tons of brass, in addition to 700 tons of copper and 1,362 tons of copper in alloys other than brass.

The production of copper from secondary sources in 1914 was equal to about 16.7 per cent of the refinery output of primary copper in the United States from all sources, or about 22.2 per cent of the primary copper smelted from domestic ore.

As contrasted with lead and zinc, the uses for which copper is principally employed are such that a large percentage of the metal can be eventually recovered and returned to the trade. The period elapsing between the time when copper enters the trade and is returned as scrap varies, of course, greatly with the uses for which it is employed, and no data are available that will give even an approximation of this period. However long this period may be, it is evident that there will be an increase in the production of copper from secondary sources proportionate to the great increase in the consumption of copper. The decrease in the production of secondary copper in 1914 can be attributed to the condition of the metal market, and gives no indication of the permanent trend of this branch of the industry.

REFINED COPPER.

The total production of new refined copper in 1914 was 1,533,781,394 pounds, a decrease of 81,286,388 pounds from the output in 1913.

The production of electrolytic, Lake, casting, and pig copper from primary sources and the production of secondary copper by the regular refining plants in 1913 and 1914 is shown in the following table:

Production of primary and secondary copper by the regular refining plants in 1913 and 1914, in pounds.

	1913		1914	
	Domestic.	Foreign.	Domestic.	Foreign.
Primary:				
Electrolytic	1,022,497,601	378,243,869	991,573,073	323,358,205
Lake	155,715,286		158,009,748	
Casting	22,606,040		21,506,325	
Pig	36,004,986		39,334,043	
Total primary	[a] 1,236,823,913	[a] 378,243,869	[a] 1,210,423,189	[a] 323,358,205
	1,615,067,782		1,533,781,394	
Secondary:				
Electrolytic	14,862,577		27,702,928	
Casting	22,360,182		4,224,052	
Total secondary	37,222,759		31,926,980	
Total output	1,652,290,541		1,565,708,374	

[a] The distribution of refined copper of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

The figures for Lake copper include the Michigan copper that was electrolytically treated.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of about 224,000,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 256,000,000 pounds from secondary sources. Of this total at least 80,000,000 pounds was produced by remelting clean scrap produced in the process of manufacture of copper and brass articles.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution of domestic plants of the United States to the world s supply of copper for 1914 is found to be 1,790,000,000 pounds.

For the first six months of 1914 reports were continued by the Copper Producers' Association of the monthly output of marketable copper by the regular refining plants of the United States. In July the publication of the monthly statistics was discontinued, and early in 1915 the association was dissolved.

Monthly output of marketable copper for the first six months of 1914, as reported by the Copper Producers' Association.

	Pounds.
January	131,770,274
February	122,561,007
March	145,651,982
April	151,500,531
May	142,308,287
June	141,345,571

COPPER SULPHATE.

The production of hydrous copper sulphate or bluestone by the refineries of the United States in 1914 was 34,411,443 pounds, having a copper content of 8,602,861 pounds, as compared with 34,270,478 pounds of bluestone, having a copper content of 8,567,620 pounds in 1913.

STOCKS.

Returns from all producing companies show that the following stocks of electrolytic, Lake, casting, and pig copper were on hand at the beginning and end of the year 1914:

Stocks of refined copper in pounds.

Jan. 1, 1914	90,385,402
Jan. 1, 1915	173,640,501
Increase during 1914	83,255,099

In addition to the stocks of refined copper, there were reported as at the smelters, in transit to the refineries, and at the refineries, blister copper and material in process of refining to the amount of 203,067,571 pounds on January 1, 1915, as compared with 247,789,811 pounds on January 1, 1914.

During the first six months of 1914 the Copper Producers' Association reported the stock of the marketable copper held at all points in the United States on the first of each month. The following table shows the stocks held on the first of each month:

Stocks of marketable copper of all kinds on hand at all points in the United States on the first day of each month from January 1, 1914, to July 1, 1914.

	Pounds.		Pounds.
January	91,438,867	May	70,337,001
February	87,296,685	June	84,342,641
March	78,371,852	July	106,110,663
April	64,609,319		

IMPORTS AND EXPORTS.

IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1914 was 306,350,827 pounds, according to the records of the Bureau of Foreign and Domestic Commerce. The imports in 1913 were 408,778,954 pounds. The following table shows the character and source of copper-bearing materials imported during 1913 and 1914:

Imports of copper into the United States in 1913 and 1914, by countries, in pounds.

Country.	Ore, matte, and regulus copper content.		Pigs, bars, ingots, plates, old, etc.	
	1913	1914	1913	1914
United Kingdom			17,943,285	5,163,126
Germany	1,067,024	4,684,668		
Spain	6,244,676	2,633,365	36,565,767	16,931,784
Canada	34,072,096	24,304,104	33,749,133	27,230,559
Mexico	18,940,530	15,495,694	97,003,847	43,193,868
Chile	25,311,542	30,562,839	18,315,000	23,814,659
Cuba	5,362,132	18,659,788		
Peru			42,667,436	44,488,809
Japan			14,376,493	10,918,069
Australia and Tasmania			22,149,355	15,130,001
Other countries	17,712,105	8,460,836	17,298,533	14,678,628
Total	108,710,105	104,801,324	300,068,849	201,549,503
Grand total			408,778,954	306,350,827

In 1914 ore to the amount of 389,953 tons, with a copper content of 85,079,140 pounds, and 27,269 tons of matte and regulus, with a copper content of 19,722,184 pounds, were imported. The copper imported as matte and blister included a considerable portion of the 16,280,000 pounds of copper in ore and matte of domestic origin that was treated in foreign plants during the year.

EXPORTS.

The exports of metallic copper from the United States in 1914 amounted to 840,080,922 pounds, according to the Bureau of Foreign and Domestic Commerce. In addition to the exports of metallic copper, the copper content of 43,529 long tons of ore, matte, and regulus was exported in 1914, as compared with the content of 65,648 long tons in 1913.

Exports of domestic copper (ingots, bars, plates, and old) from the United States in 1913 and 1914, by countries, in pounds.

Country.	1913	1914
United Kingdom	133,679,641	198,382,459
Austria-Hungary	34,648,205	26,989,548
Belgium	7,102,120	5,429,717
France	160,000,345	150,839,897
Germany	307,150,761	176,698,948
Italy	41,568,713	67,415,944
Netherlands	178,940,289	126,001,150
Russia in Europe	7,907,672	8,731,272
Other Europe	14,357,014	45,634,229
Canada	35,982,207	24,221,498
Other countries	4,904,125	9,736,260
Total	[a] 926,241,032	840,080,922

[a] Includes sheets, rods, wires, etc.

The copper exported was in the following forms:

	Pounds.
Pigs, ingots, and bars	748,902,137
Plates and sheets	53,750,837
Rods and wire	32,647,594
All other	4,780,354
Ore, matte, and regulus	87,058,000

The value of the exports of copper is reported by the Bureau of Foreign and Domestic Commerce as $146,377.621 in 1913 and $117,633,145 in 1914.

CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1914 was about 711,624,000 pounds. In 1913 it was about 812,268,000 pounds. The method employed in determining the quantity of copper retained for domestic consumption is shown in the following table, which does not include stocks of copper held by consumers:

Apparent domestic consumption of refined new copper in 1912, 1913, and 1914, in pounds.

	1912	1913	1914
Total refinery output of new copper	1,568,104,478	1,615,067,782	1,533,781,394
Stock at beginning of year	88,372,195	105,497,683	90,385,402
Total available supply	1,656,476,673	1,720,565,465	1,624,166,796
Refined copper exported	[a] 775,000,658	[a] 817,911,424	[a] 748,902,137
Stocks at end of year	105,497,683	90,385,402	173,640,501
Total withdrawn from supply	880,498,341	908,296,826	922,542,638
Apparent consumption	775,978,332	812,268,639	711,624,158

[a] Exports of pigs, ingots, and bars reported by the Bureau of Foreign and Domestic Commerce.

If to the 711,624,158 pounds of new refined copper is added the 256,000,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of about 968,000,000 pounds of new and old copper was available for domestic consumption.

The following table shows the monthly deliveries of copper for domestic consumption and export as reported by the Copper Producers' Association:

Monthly deliveries of copper for domestic consumption and for export for the first six months of 1914 as reported by the Copper Producers' Association, in pounds.

Month.	Domestic consumption.	Export.	Total.
January	47,956,955	47,955,501	135,912,456
February	47,586,657	83,899,183	131,485,840
March	69,852,349	89,562,166	159,414,515
April	63,427,633	82,345,216	145,772,849
May	55,592,170	72,710,477	128,302,647
June	46,227,353	73,350,196	119,577,549

USES.

No systematic attempt has been made to ascertain the proportion of the copper output of 1914 used in different industries, as electric transmission, brass manufacture, casting, and so on. Some idea of the quantities entering the different industries can be gained from the forms in which the output of the refineries was cast. The following table shows the approximate quantity of copper cast in the different forms during 1914 as reported by the refining companies. It will be noted that the total is not the same as the refinery output for 1914.

Forms in which copper was cast in 1914, in pounds.

Form.	Total.	Percentage.
Wire bars	775,295,279	52
Ingots and ingot bars	429,744,310	29
Cakes	148,881,215	10
Cathodes	114,404,472	7
Other forms	34,521,860	2
Total	1,502,847,136	100

It may be assumed that a large portion of the 52 per cent cast as wire bars was used for electrical purposes and that the 10 per cent cast as cakes was used largely for rolling. The other forms are less easily classified. The 7 per cent cast as cathodes, together with a portion of the ingots, probably entered the brass industry, and a large quantity of copper ingots was used in casting. The refinery output for 1913 was cast as follows: Wire bars, 58 per cent; ingots, 23 per cent; cakes, 9 per cent; cathodes, 8 per cent; other forms, 2 per cent.

PRICES.

The average yearly quoted price of electrolytic copper at New York in 1914 was 13.31 cents a pound; in 1913 the price was 15.52 cents a pound. The average monthly prices for electrolytic copper in 1912, 1913, and 1914, as reported in "Metal Statistics," American Metal Market Co., are given in the following table:

Average monthly prices at New York per pound of electrolytic copper in 1912, 1913, and 1914, in cents.

Month.	Price of electrolytic copper, in cents.		
	1912	1913	1914
January	14.27	16.755	14.45
February	14.26	15.27	14.67
March	14.78	14.925	14.335
April	15.85	15.48	14.34
May	16.16	15.63	14.13
June	17.29	14.85	13.81
July	17.35	14.57	13.49
August	17.60	15.68	12.415
September	17.67	16.55	12.085
October	17.60	16.54	11.40
November	17.49	15.47	11.74
December	17.505	14.47	12.93
Average	16.48	15.52	13.315

The average yearly price of Lake copper was 13.61 cents. New York quotations are used by the United States Geological Survey in calculating the value of both mine and smelter output. It is well known, however, that this average yearly price only approximates the actual average price received for copper sold during the year.

The average selling price received by several large producers of electrolytic copper, as given in their annual reports, varies from 13.14 cents to 13.74 cents, with an average of 13.44 cents a pound, which indicates that the average price derived from the quotations was somewhat below the actual average price realized by producers.

For Lake copper the average price received by the companies reporting was 13.4 cents a pound.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO IN 1914.

(MINES REPORT.)

By C. N. Gerry.

PRODUCTION.

The value of the mine production of gold, silver, copper, lead, and zinc in Idaho in 1914 was $24,645,848, an increase of $496,799 over the value in 1913. This was not a large increase, as the metal market was dull during half the year; but the total value was greater than in any previous year. Marked increase, and, in fact, a record production, was made in silver, lead, and zinc, but there was decrease in gold, in copper, and in the quantity of ore marketed or treated.

Ore sold or treated in Idaho, 1904–1914, number of producers, and content and total value of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	360	1,668,327	$1,710,365	7,666,382	5,087,518	233,096,375	2,600	$16,933,405
1905	257	1,669,038	1,075,618	8,679,093	7,321,585	259,812,428	1,228,449	19,743,620
1906	287	1,787,673	1,149,100	9,018,815	9,558,913	255,014,446	2,065,597	23,698,400
1907	359	1,690,860	1,255,911	8,415,431	10,890,731	233,823,854	6,985,732	21,793,064
1908	385	1,689,231	1,443,459	7,469,981	10,041,850	206,827,816	37,410	15,416,599
1909	324	1,772,383	1,453,822	7,041,633	9,115,489	215,986,285	1,351,010	15,660,849
1910	417	1,786,174	1,096,842	7,369,742	7,037,292	228,258,839	5,603,114	16,316,196
1911	309	2,170,897	1,372,387	8,196,136	5,152,937	272,556,525	8,340,249	19,100,894
1912	408	2,266,334	1,381,214	8,294,745	7,492,152	284,185,657	13,905,502	21,466,521
1913	384	2,451,592	1,344,559	9,989,193	9,592,966	317,871,945	23,173,953	24,149,049
1914	384	2,235,349	1,152,315	12,479,516	6,445,187	348,526,069	42,012,435	24,645,848
Increase (+) or decrease (−) in 1914	.....	−216,243	−192,244	+2,490,323	−3,147,779	+30,654,124	+18,838,482	+496,799

An approximation of the production of the State from the discovery of placer gold to the end of 1914 is given below by periods. This table will appear in a later publication giving the production by years, and is subject to revision. It shows, however, that the State has had a substantial production of the five metals, valued at more than $480,621,000. Of this total lead represents 42.45 per cent, or $204,023,108; silver is next, with 26.80 per cent, or $128,806,745; gold is valued at $127,810,619, or 26.59 per cent; copper at $14,117,571, or 2.94 per cent; and zinc (spelter) at $5,863,296, or 1.22 per cent.

Production of gold, silver, copper, lead, and zinc in Idaho from 1863 to 1914, by periods.

Period.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Pounds.*	
1863–1870	2,499,887.00	$51,675,200	2,176,738	$2,900,000	.....	.....
1871–1880	907,453.00	18,758,707	3,152,989	3,887,778	.....	.....
1881–1890	852,150.00	17,615,293	24,866,722	25,597,231	380,781	$53,564
1891–1900	993,496.00	20,537,380	44,856,082	30,757,036	3,685,465	447,579
1901–1914	929,968.86	19,224,039	113,554,085	65,664,700	89,014,115	13,616,428
Total	6,182,954.86	127,810,619	188,606,616	128,806,745	93,080,361	14,117,571

Period.	Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1863–1870	.....	.....	.....	.....	$54,575,200
1871–1880	700,000	$38,200	.....	.....	22,684,685
1881–1890	329,801,639	14,343,777	.....	.....	57,609,865
1891–1900	965,942,461	37,416,132	.....	.....	89,158,127
1901–1914	3,360,263,384	152,224,999	104,706,051	$5,863,296	256,593,462
Total	4,656,707,484	204,023,108	104,706,051	5,863,296	480,621,339

Output of ore and production of metals in Idaho in 1914, by kinds of ore.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	208	.....	33,884.46	7,071	.....	.....	.....
Dry or siliceous ore	98	43,513	17,582.57	39,002	5,433	4,376	.....
Copper ore	11	93,040	1,076.54	239,355	4,986,206	.....	.....
Lead ore	60	1,421,893	2,467.13	8,697,580	1,128,859	261,689,295	.....
Zinc ore	4	8,473	6.77	5,039	.....	9,473	6,559,167
Lead-zinc ore	10	668,430	725.77	3,491,469	324,689	86,822,925	35,453,268
Total	.....	2,235,349	55,743.24	12,479,516	6,445,187	348,526,069	42,012,435

PRODUCTION OF ORE IN 1914.

The quantity of ore sold or treated in Idaho decreased from 2,451,592 tons in 1913 to 2,235,349 tons in 1914, a decrease of 216,243 tons, or 8.82 per cent. The main ores, as seen below, are lead ore and lead-zinc ore, the former being 63.61 per cent of the total and the latter 29.90 per cent. Copper ore constituted 4.16 per cent of the total; siliceous ore, 1.95 per cent; and zinc ore, only 0.37 per cent. Much of the lead ore contains zinc that is not saved. The total ore mined and treated had an average value per ton, in gold and silver, of $3.29; the siliceous ore, $8.85; the copper ore, $1.66; the lead ore, $3.42; the lead-zinc ore, $2.91; and the zinc ore, 35 cents. The siliceous ore sold or treated averaged per ton as follows: Gold, $8.35; silver, 0.90 ounce; and copper, 0.006 per cent. The siliceous ore included 37,098 tons of gold ore, averaging $7.47 in gold, 0.47 ounce of silver, 0.09 pound of copper, and 0.002 pound of lead; 44 tons of gold

and silver ore, averaging $43.41 in gold, 76 ounces of silver, and 39.77 pounds of lead; and 1,100 tons of silver ore, averaging $3.32 in gold, 14.15 ounces of silver, 1.54 pounds of copper, and 2.33 pounds of lead. The copper ore averaged 24 cents in gold, 2.57 ounces of silver, and 2.68 per cent of copper. The averages of copper ore and concentrate shipped, as well as those of the lead and zinc ores, are shown under special tables herein. Lead ore averaged 3 cents in gold, 6.12 ounces of silver, 0.04 per cent copper, and 9.20 per cent lead. The zinc ore averaged 2 cents in gold, 0.59 ounce of silver, 0.06 per cent lead, and 38.71 per cent zinc. Lead-zinc ore averaged 2 cents in gold, 5.22 ounces of silver, 0.02 per cent copper, 6.49 per cent lead, and 2.65 per cent zinc.

The output of siliceous ore and copper ore decreased largely in 1914, but the production of lead-zinc ore increased greatly.

Sudivision of ore sold or treated in Idaho in 1914, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Ada	3					3
Adams	930	94				1,024
Blaine	607		3,255	613	3,228	7,703
Boise	17,067					17,067
Bonner	27		431			458
Cassia	14					14
Clearwater	6					6
Custer	3,010	17,814	966			21,790
Elmore	3,239					3,239
Fremont			8,267			8,267
Idaho	4,276	43				4,319
Lemhi	12,572	43	4,935			17,550
Owyhee	1,641					1,641
Shoshone	121	75,046	1,404,039	7,860	665,202	2,152,268
Total	[a] 43,513	93,040	1,421,893	8,473	668,430	2,235,349
Average value per ton in gold and silver	$8.85	$1.66	$3.42	$0.35	$2.91	$3.29

[a] Includes 37,098 tons of gold ore, 44 tons of gold and silver ore, 1,100 tons of silver ore, and 5,271 tons of iron ore.

Only 34,861 tons, or 1.56 per cent, of the ore was treated in gold and silver mills, against 53,630 tons in 1913. Bullion from this ore (and from 3,110 tons of old tailings) treated by amalgamation or cyanidation was valued at $262,099, or $6.90 a ton of ore and tailings treated. Boise County supplied most of the ore amalgamated, and Lemhi County was next. At these mills during 1914 about 598 pounds of mercury were consumed and 32,529 pounds of potassium and sodium cyanide. The average consumption of quicksilver was 0.023 pound per ton of ore amalgamated and 0.042 pound per ounce of gold and silver bullion saved. The cyanide consumption was 1.80 pounds per ton of ore and tailings treated and 2.53 pounds per ounce of gold and silver bullion.

Ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Idaho in 1914, by counties.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine oz.*	*Fine oz.*	*Fine oz.*	*Fine oz.*	
Ada	3	2.95	5			$64
Adams	930			186.42	22	3,865
Blaine	523	390.08	180			8,164
Boise	[a] 17,001	4,974.29	1,102	370.00	80	111,130
Clearwater	5	3.53	1			73
Custer	[b] 500	721.48	1,551	[c] 300.07	[c] 1,318	22,704
Elmore	[d] 3,216	67.55	39	354.82	560	9,063
Idaho	[e] 4,240	754.75	217	272.19	108	21,408
Lemhi	6,691	1,748.05	226	[f] 1,318.89	[f] 1,319	64,253
Owyhee	[b] 1,640	616.69	1,538	142.59	6,482	20,131
Shoshone	112	59.67	19			1,244
Total	34,861	9,339.04	4,878	2,944.98	9,889	262,099

[a] Also yielded 257 tons of concentrates.
[b] Also yielded 5 tons of concentrates.
[c] Produced from 2,500 tons of old tailings.
[d] Also yielded 3 tons of concentrates.
[e] Also yielded 7 tons of concentrates.
[f] Includes bullion from 610 tons of old tailings.

By far the greatest part of the ore produced, 2,066,361 tons, or 92.44 per cent, was concentrated. Concentrates from this ore and from old tailings treated and concentrates from a small quantity of ore worked in gold and silver mills aggregated 303,046 tons of concentrates, valued at $17,532,115, or $57.85 a ton. The concentrates were largely from the Coeur d'Alene region and the ratio was 6.82 tons of crude ore into 1 ton of concentrate. A considerable output of lead-zinc concentrates was sold. This class contained over 4.5 per cent of lead, as well as a marketable zinc product. An increased output of zinc concentrates was made, and a much greater increase is expected in 1915.

Mine production of gold, silver, copper, lead, and zinc from Idaho concentrates in 1914.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine oz.*	*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
Blaine	5,646	1,353	77.02	42,292	3,495	404,675	476,264	$65,516
Boise		257	761.65	2,085				16,898
Bonner	324	81	.21	1,327	40	121,914		5,497
Custer		5	55.90	5,031				3,937
Elmore		3	48.36	120				1,066
Fremont	6,270	2,144	1.79	9,948	4,110	2,351,808		97,806
Idaho		7	27.41	36	78			596
Lemhi		2	1.10	15	197			57
Owyhee		5	25.21	2,916				2,134
Shoshone	2,054,121	299,189	2,169.84	8,781,540	3,234,374	262,831,540	34,450,175	17,338,608
Total	2,066,361	303,046	3,168.49	8,845,309	3,242,294	265,709,937	34,926,439	17,532,115

By kinds of concentrates.

Dry or siliceous		277	918.54	10,188	78			$24,632
Copper		5,031	69.71	139,791	2,228,579			375,146
Lead		251,714	2,171.25	8,612,849	1,013,637	264,108,786		15,242,847
Zinc		39,492	6.75	21,257		107,288	30,369,331	1,564,914
Lead-zinc		6,532	2.24	61,224		1,493,863	4,557,108	324,576

By ascertaining the average content of each kind of concentrate, it will be seen that the mills are making a better product each year. This is especially true of lead concentrates and of zinc concentrates.

Kind of concentrate and average metallic content of each kind produced in Idaho in 1911–1914.

Kind and source of concentrates.	Concentrate.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:							
Gold and silver mills—	*Short tons.*	*Value per ton.*	*Fine oz. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	689	$51.00	46.82	0.06	0.70	.....	$76.61
1912	263	81.16	43.91	.39	3.24	.....	112.37
1913	493	70.44	7.78	.08	.10	.....	75.48
1914	277	68.55	36.78	.01	.....	.....	88.92
Concentration mills—							
1911	793	9.62	3.93	.15	.02	.....	12.08
1912	157	42.50	4.04	.15	1.00	.....	46.38
1913	1	103.00	2.00	.....	.....	.....	104.00
Copper:							
Concentration mills—							
1912	842	.41	22.33	20.35	.....	.....	81.30
1913	5,482	.24	25.63	20.39	.....	.....	78.93
1914	5,031	.29	27.79	22.15	.....	.....	74.57
Lead:							
Gold and silver mills—							
1911	8	45.00	12.50	.....	10.24	.....	60.88
Concentration mills—							
1911	209,060	.26	24.81	.14	48.69	.....	57.58
1912	212,512	.25	25.24	.11	48.82	.....	60.08
1913	233,113	.22	28.00	.10	50.75	.....	62.12
1914	251,714	.18	34.22	.20	52.46	.....	60.56
Zinc:							
Concentration mills—							
1911	12,198	.....	.....	.....	.....	33.98	38.74
1912	18,573	.01	.35	.01	.21	35.94	50.04
1913	30,311	.02	1.57	.01	.56	34.50	40.13
1914	39,492	.....	.54	.....	.14	38.45	39.63
Lead-zinc:							
Concentration mills—							
1914	6,532	.01	9.37	.....	11.43	34.88	49.69

Of the total ore, 130,512 tons, or 5.84 per cent, was shipped crude to smelters. A large part of this ore, in Shoshone and Fremont counties, is picked from the belts as it comes into the mills. With the exception of ore smelted at Clayton, in Custer County, all this ore went to plants outside the State. Shoshone, Custer, Lemhi, Fremont, and Blaine counties supplied most of it, and the shipping ore contained metals valued at $6,147,270, or $47.10 a ton. There was a marked decrease in output of copper ore and a considerable decrease in lead ore. However, there was increase in shipments of smelting zinc ore and of siliceous ore. The combined value of the concentrates and the crude ore shipped, most of which went to distant smelters, was $23,679,385.

Mine production of gold, silver, copper, lead, and zinc from Idaho crude ore shipped to smelters in 1914.

By counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Adams	94	2.00	384	31,911	.....	.....	$4,498
Blaine	1,129	203.91	43,701	5,594	689,001	12,788	56,682
Boise	66	111.94	4,413	80	2,187	.....	4,878
Bonner	134	2.98	5,818	1,836	108,491	.....	7,754
Cassia	14	.44	161	86	518	.....	130
Clearwater	1	2.90	6	.....	.....	.....	63
Custer	18,790	1,115.00	82,300	2,110,909	341,238	.....	362,053
Elmore	23	34.40	337	.....	.....	.....	897
Fremont	1,997	.....	8,905	2,707	1,997,023	.....	83,169
Idaho	70	77.98	511	6,379	.....	.....	2,743
Lemhi	10,240	4,078.69	69,038	35,103	2,810,722	.....	236,779
Owyhee	1	1.00	5	.....	66	.....	39
Shoshone	97,935	774.43	3,396,620	1,008,288	76,866,886	7,073,208	5,386,985
Total	130,512	6,406.27	3,612,369	3,202,893	82,816,132	7,085,996	6,147,270
By kinds of ore.							
Dry or siliceous	5,542	4,378.92	14,032	5,158	4,376	.....	$99,138
Copper	24,546	1,007.95	99,579	2,757,824	.....	.....	442,694
Lead	91,694	1,019.40	3,484,340	439,911	82,706,527	.....	5,231,975
Zinc	7,879	.....	149	.....	.....	6,436,109	328,324
Lead-zinc	851	.....	14,269	.....	105,229	649,887	45,139

As in the case of concentrates, there was an increase in metallic content of ore smelted, not only in the lead and zinc in the crude ore, but also in the silver content of the lead ore smelted.

Crude ore, by kinds, and average metallic content of each kind, produced in Idaho and shipped to smelters in 1911–1914.

Kind of crude ore.	Ore.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	940	$16.02	18.42	0.38	0.39	.....	$27.08
1912	1,398	20.80	13.52	.28	.....	.....	30.32
1913	4,250	15.10	4.57	.08	.08	.....	18.17
1914	5,542	16.33	2.53	.05	.04	.....	17.89
Copper:							
1911	40,061	2.32	6.34	4.96	.....	.....	18.08
1912	82,707	.50	5.24	3.82	.....	.....	16.34
1913	67,317	1.53	4.07	4.30	.....	.....	19.15
1914	24,546	.85	4.05	5.62	.....	.....	18.03
Lead:							
1911	95,840	.36	25.23	.30	35.97	.....	46.85
1912	108,986	.32	20.44	.15	35.13	.....	45.01
1913	106,980	.30	26.77	.13	37.81	.....	50.15
1914	91,694	.23	38.00	.24	45.10	.....	57.06
Zinc:							
1911	50	.....	1.98	.....	.....	35.28	41.26
1912	736	.....	.....	.....	.....	37.67	51.99
1913	2,867	.04	.33	.....	.12	39.39	44.48
1914	7,879	.....	.02	.....	.....	40.84	41.67
Copper-lead:							
1912	1	.....	7.00	9.10	8.50	.....	42.00
Lead-zinc:							
1911	41	1.97	8.32	.....	21.05	18.41	46.32
1914	851	.....	16.77	.....	6.18	38.18	53.04

An approximate separation of the crude smelting ore into oxidized and sulphide ores shows that most of the material is sulphide. Only about one-fourth of the copper ore is oxidized and about 7 per cent of the lead ore is oxidized. The camp of Gilmore, in Lemhi County, supplies most of this oxidized lead ore.

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Idaho and shipped to smelters in 1914, and metallic content, by kinds.

Kind of ore.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	5,542	4,378.92	14,032	5,158	4,376	.....	$99,138
Copper:							
Oxidized	6,277	393.33	23,008	762,922	.....	.....	120,461
Sulphide	18,269	704.62	76,571	1,994,902	.....	.....	322,233
Lead:							
Oxidized	6,243	139.03	82,048	20,471	3,763,831	.....	197,772
Sulphide	85,451	879.77	3,402,292	419,440	78,942,696	.....	5,034,203
Zinc:							
Sulphide	7,879	.....	149	.....	.....	6,436,109	328,324
Lead-zinc:							
Sulphide	851	.....	14,269	.....	105,229	649,887	45,139
Total	130,512	6,406.27	3,612,369	3,202,893	82,816,132	7,085,996	6,147,270

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Idaho and shipped to smelters in 1913 and 1914.

Kind of ore.	Ore.	Average metallic content.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1913	4,250	$15.10	4.57	0.08	0.08	.....	$18.17
1914	5,542	16.33	2.53	.05	.04	.....	17.89
Copper:							
Oxidized—							
1913	27,166	1.09	3.02	5.74	.....	.....	20.70
1914	6,277	1.00	3.66	6.08	.....	.....	19.19
Sulphide—							
1913	40,151	1.82	4.78	4.32	.....	.....	18.10
1914	18,269	.80	4.19	5.46	.....	.....	17.64
Lead:							
Oxidized—							
1913	18,752	.46	12.29	.11	25.42	.....	30.60
1914	6,243	.46	13.14	.16	30.14	.....	31.68
Sulphide—							
1913	88,228	.27	29.85	.13	40.45	.....	54.30
1914	85,451	.21	39.82	.25	46.19	.....	58.91
Zinc:							
Sulphide—							
1913	2,867	.04	.33	.....	.12	39.39	44.48
1914	7,879	.....	.02	.....	.....	40.84	41.67
Lead-zinc:							
Sulphide—							
1914	851	.....	16.77	.....	6.18	38.18	53.04
Total—							
1913	181,414	1.10	17.41	1.89	22.30	.62	37.81
1914	130,512	1.01	27.68	1.23	31.73	2.71	47.10

GOLD.

The mine production of gold was 55,743.24 fine ounces, valued at $1,152,315, against 65,043.04 ounces, valued at $1,344,559, in 1913, a decrease of 14.3 per cent, or $192,244. There was increase in various counties, especially Lemhi, but the general decrease was caused by the

exhaustion of the De Lamar mine in Owyhee County and the idleness of the Lost Packer smelter in Custer County. For the second time in recent years the output of placer gold exceeded that from lode mines. Gold valued at $700,454 came from 208 placers and gold valued at $451,861 came from 176 lode mines. Of the placer production of gold, $568,989, or about 81 per cent, was won by 4 dredges; $1,014, by drift mining, and $130,451 by hydraulic or sluicing methods. Of the total gold, 60.8 per cent came from placers, 31.5 per cent from siliceous ore, 4.43 per cent from lead ore, 1.93 per cent from copper ore, and 1.30 per cent from lead-zinc ore. Siliceous ore contained $8.35 a ton in gold; copper ore, 24 cents; lead ore, 3 cents; and zinc ore and lead-zinc ore, 2 cents. Snake River in various counties supplied $5,348 in fine gold. The production of gold from amalgamation and cyanidation mills continues to decrease. In 1914 bullion recovered at these mills contained 12,284.02 ounces of gold, or 22.04 per cent of the total, against 17,552.49 ounces in 1913. Amalgamation won the greater part of this total, or 9,339.04 ounces of gold, and cyanidation 2,944.98 ounces. Concentrates of all kinds contained only 3,168.49 ounces of gold, or 5.68 per cent of the total gold, an average of 22 cents a ton. Siliceous concentrates were valued at $88.92 a ton. Crude ore shipped to smelters contained 6,406.27 ounces of gold, or 11.49 per cent of the total. The smelting ore averaged in gold $1.01 a ton; the siliceous ore, $16.33; the copper ore, 85 cents; and the lead ore, 23 cents. Boise and Lemhi counties are still the leading gold producers, principally from dredging.

Dredging operations in Idaho, according to the available records, began in 1897 with the Sweetser Burroughs dredge on Snake River, in Cassia County. This plant was run until 1903, when the output became small. In 1897 and 1898 the dredge output of gold was valued at $25,356. In 1899 there were five dredges active, which produced $62,436 in gold. These were the Bed Rock, Boise, and old Boston & Idaho in Boise County, Pacific in Lemhi County, and Sweetser in Cassia County. In 1900 six plants contributed $129,443 in gold. The Yale and Abbott boats in Lincoln County and the Sawtooth in Custer County were added. The Boston-Idaho, Pacific, and Sweetser continued operations. The same six boats operated in 1901 and produced $116,117 in gold. In 1902 there were ten plants at work, which turned out $101,257 in gold, but six of them made very small outputs. They were the Bonanza and Idaho Gold, in Bingham County; Boston & Idaho, Blain, and Gold Fork, in Boise County; Sweetser Burroughs, Pacific, Acme, Yale, and Northern, the last named being in Shoshone County. Six plants in 1903 produced $86,113. The Stanley in Custer County and the Delta in Shoshone County were added, and the others were the Boston & Idaho, Blain, Sweetser Burroughs, and Pacific. In 1904 seven boats had a gold output of $99,110. The Moline had the largest output, and the others in order of production were: The Boston & Idaho, Wommacks, Centerville, Mascot (Shoshone County), Idaho (Bingham County), and Pacific. In 1905 only three plants were producing gold; the Moline, Stanley, and Mascot produced $34,336. In 1906 there were three plants operating in Boise, Stanley, and Nez Perce counties. These produced $38,340 in gold and were the Moline, Wommacks, and Idaho Co. In 1907 six plants produced $74,438 in gold. These were the Snake River dredge in Bingham County, the Moline, Idaho Co.,

Mascot, Stanley, and Mullen dredge in Lemhi County. In 1908 five boats produced $77,189 in gold from Boise, Idaho, Custer, Lemhi, and Nez Perce counties. They were the Moline, Stanley, Big Sandy, Mullen, and Idaho Co. In 1909 eight plants gave a gold output of $101,704. These included the Boston & Idaho, Moline, Willis, Stanley, Mullen, Idaho Co., and the Elk City dredge and the Jennings dredge, both at Elk City, in Idaho County. In 1910 six plants produced $91,247 in gold—the Boston & Idaho, Moline, Jennings, Mullen, Idaho Co., and a small plant in Oneida County. Since that time gold from this source has steadily increased on account of the big plant of the Boston & Idaho and the Kirtley Creek. In 1911 seven boats produced $258,791 in gold. These were the Boston & Idaho (2), Moline, Idaho, and Sprague, now in Clearwater County, and the Mullen and Kirtley Creek, in Lemhi County. In 1912 eight plants produced $481,077, but only three were important producers—they were the Boston-Idaho (2), Idaho Co., Sprague, Willis, Mullen, Kirtley Creek, and a small experimental plant. In 1913 six plants had an output of $561,876 in gold. The important producers were the Kirtley Creek and Boston & Idaho boats; others were the Sprague, Willis, Mullen, and Bohannon. In 1914 four plants had a gold output of $568,989. These were the Boston & Idaho and Pierce Co. in Clearwater County, and Kirtley Creek and Bohannon in Lemhi County. To the end of 1914 Idaho dredges have therefore produced approximately $2,907,819.

Source of mine production of gold in Idaho, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Ada	122.53	2.95					125.48
Adams	18.53	186.44	1.98				206.95
Bingham	43.83						43.83
Blaine	7.16	476.20		182.57	6.77	5.47	678.17
Boise	22,866.48	6,217.88					29,084.36
Bonner		3.00		.19			3.19
Bonneville	190.45						190.45
Cassia		.44					.44
Clearwater	904.08	6.43					910.51
Custer	202.69	1,216.42	971.24	4.79			2,395.14
Elmore	463.82	505.13					968.95
Fremont				1.79			1.79
Gooding	31.01						31.01
Idaho	982.48	1,132.33					2,114.81
Kootenai	126.74						126.74
Latah	33.86						33.86
Lemhi	7,655.60	6,974.61	11.37	160.75			14,802.33
Nez Perce	.68						.68
Owyhee	74.60	786.09					860.69
Power	33.76						33.76
Shoshone	99.65	74.65	91.95	2,117.04		720.30	3,103.59
Twin Falls	26.51						26.51
Total	33,884.46	[a] 17,582.57	1,076.54	2,467.13	6.77	725.77	55,743.24

[a] Includes 13,407.04 ounces from gold ore, 92.42 ounces from gold and silver ore, 176.56 ounces from silver ore, and 3,906.55 ounces from iron ore.

SILVER.

The mine production of silver increased from 9,989,193 ounces, valued at $6,033,473, in 1913 to 12,479,516 ounces, valued at $6,901,172, in 1914, an increase of 2,490,323 ounces, or 25 per cent. The rate of increase was greater than this in the Coeur d'Alene region, but decrease

in the other regions reduced the net total. There was a large increase in the output of silver from lead-zinc ore and a good increase from lead ore, but a decrease from siliceous ore and copper ore. The largest part of the total silver yield, or 69.7 per cent, was from lead ore. The lead-zinc ore supplied about 28 per cent, copper ore 1.92 per cent, and siliceous ore only 0.31 per cent. Shoshone County produced 97.6 per cent of the silver, and Custer County was next with only 90,346 ounces, and the decrease in Custer, Lemhi, and Owyhee counties was notable. The different classes of ore had the following averages per ton in silver: Siliceous ore, 0.90 ounce; copper ore, 2.57 ounces; lead ore, 6.12 ounces; and lead-zinc ore, 5.22 ounces. Concentrates supplied most of the silver, 8,845,309 ounces, or 70.88 per cent. Crude ore contained 3,612,369 ounces, or 28.95 per cent; and gold and silver bullion contained 14,767 ounces, or only 0.12 per cent. Crude ore averaged 27.68 ounces a ton and concentrates 29.19 ounces a ton.

Source of mine production of silver in Idaho, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Ada	27	5	.....	.....	.....	.....	32
Adams	3	22	384	.....	.....	.....	409
Bingham	3	.....	.....	.....	.....	.....	3
Blaine	1	675	.....	68,049	5,039	12,470	86,234
Boise	5,711	7,730	.....	.....	.....	.....	13,441
Bonner	.....	3,816	.....	3,328	.....	.....	7,144
Bonneville	4	.....	.....	.....	.....	.....	4
Cassia	.....	161	.....	.....	.....	.....	161
Clearwater	219	7	.....	.....	.....	.....	226
Custer	86	9,545	61,796	18,919	.....	.....	90,346
Elmore	135	1,056	.....	.....	.....	.....	1,191
Fremont	.....	.....	.....	18,853	.....	.....	18,853
Gooding	2	.....	.....	.....	.....	.....	2
Idaho	212	819	53	.....	.....	.....	,084
Kootenai	10	.....	.....	.....	.....	.....	10
Latah	3	.....	.....	.....	.....	.....	3
Lemhi	620	4,202	120	66,276	.....	.....	71,218
Owyhee	11	10,941	.....	.....	.....	.....	10,952
Power	6	.....	.....	.....	.....	.....	6
Shoshone	15	23	177,002	8,522,155	.....	3,478,999	12,178,194
Twin Falls	3	.....	.....	.....	.....	.....	3
Total	7,071	[a] 39,002	239,355	8,697,580	5,039	3,491,469	12,479,516

[a] Includes 17,456 ounces from gold ore, 3,344 ounces from gold and silver ore, 15,560 ounces from silver ore, and 2,642 ounces from iron ore.

COPPER.

The mine production of copper decreased from 9,592,966 pounds, valued at $1,486,910, in 1913 to 6,445,187 pounds, valued at $857,210, in 1914—a decrease of 3,147,779 pounds, or 33 per cent. This decrease was general on account of the market conditions, but was noted particularly in Custer and Shoshone counties. In the former county, the output of the Empire property decreased nearly 50 per cent and the Lost Packer mine was idle. The output of the Snow Storm mine at Larson was about 40 per cent less than in 1913. The National mine did not add much to the output. More than 77 per cent of the total copper output was from copper ore, 17.5 per cent came from lead ore, and 5 per cent from lead-zinc ore. The production was nearly evenly divided between crude ore and concentrates; crude ore supplied 3,202,893 pounds and concentrates 3,242,294 pounds. Crude

copper ore shipped averaged 5.62 per cent copper and concentrates 22.15 per cent.

Source of mine production of copper in Idaho, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Lead-zinc ore.	Total.
Adams	.....	31,911	.....	.....	31,911
Blaine	2,315	.....	5,176	1,598	9,089
Boise	80	.....	.....	.....	80
Bonner	1,447	.....	429	.....	1,876
Cassia	86	.....	.....	.....	86
Custer	.....	2,109,022	1,887	.....	2,110,909
Fremont	.....	.....	6,817	.....	6,817
Idaho	1,247	5,210	.....	.....	6,457
Lemhi	258	11,741	23,301	.....	35,300
Shoshone	.....	2,828,322	1,091,249	323,091	4,242,662
Total	[a] 5,433	4,986,206	1,128,859	324,689	6,445,187

[a] Includes 3,682 pounds from gold ore, 1,690 pounds from silver ore, and 61 pounds from iron ore.

LEAD.

The mine production of lead increased from 317,871,945 pounds, valued at $13,986,366, in 1913 to 348,526,069 pounds, valued at $13,592,517, in 1914. This output establishes a new record for the State in quantity, but, on account of the price, the value declined in 1914. The increase in quantity was 30,654,124 pounds, or 9.64 per cent. A great part of the remarkable increase in Shoshone County was offset by decrease in Lemhi, Fremont, and Custer counties. Lead ore supplied 75.08 per cent of the total, and lead-zinc nearly all the remainder, or 24.91 per cent. The large increase was from lead-zinc ore. The recoverable lead in all ores sold or treated averaged 7.80 per cent; that in lead ore, 9.20 per cent; and that in lead-zinc ore, 6.49 per cent. Crude lead ore shipped averaged 45.10 per cent of recoverable lead, and lead concentrates 52.46 per cent. Concentrates of all kinds produced 265,709,937 pounds of lead, or 76 per cent of the total. Lead concentrates had an average value per ton of $60.56. Crude ore shipped was the source of 82,816,132 pounds of lead, or 24 per cent of the total. Lead ore shipped to smelter had an average value per ton of $57.06.

Source of mine production of lead in Idaho, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Blaine	1,605	947,055	9,473	135,543	1,093,676
Boise	2,187	.....	.....	.....	2,187
Bonner	.....	230,405	.....	.....	230,405
Cassia	518	.....	.....	.....	518
Custer	.....	341,238	.....	.....	341,238
Fremont	.....	4,348,831	.....	.....	4,348,831
Lemhi	.....	2,810,722	.....	.....	2,810,722
Owyhee	66	.....	.....	.....	66
Shoshone	.....	253,011,044	.....	86,687,382	339,698,426
Total	[a] 4,376	261,689,295	9,473	86,822,925	348,526,069

[a] Includes 66 pounds from gold ore, 1,750 pounds from gold and silver ore, and 2,560 pounds from silver ore,

ZINC.

The mine production of zinc (calculated as spelter) increased from 23,173,953 pounds, valued at $1,297,741, in 1913 to 42,012,435 pounds, valued at $2,142,634, in 1914. This increase of 18,838,482 pounds, or 81 per cent, came from the Coeur d'Alene region and largely from the Consolidated Interstate Callahan property, which has developed into Idaho's greatest zinc mine. Lead-zinc ore supplied most of the spelter, or 84.39 per cent, and zinc ore the remainder, or 15.61 per cent. Both the zinc concentrates and the crude zinc ore shipped are sulphide in character. From concentrates, both zinc and lead-zinc, 34,926,329 pounds of recoverable spelter were won, or 83.13 per cent of the total; and from crude ore shipped 7,085,996 pounds were won, or 16.87 per cent of the total. The use of flotation, in conjunction with wet concentration, for the saving of both lead and zinc is becoming general at the large mills of Shoshone County. Roasting and magnetic separation are used at the Success and the Frisco mills.

Source of mine production of zinc (spelter), by kinds of ore, in Idaho in 1914, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Blaine	135,846	353,206	489,052
Shoshone	6,423,321	35,100,062	41,523,383
Total	6,559,167	35,453,268	42,012,435

The sources of the production of zinc and their actual assay in zinc without deduction for losses in smelting are shown below. There were 54,754 tons of zinc ore, zinc concentrates, lead-zinc ore, and lead-zinc concentrates shipped, of which the gross assay content was 49,460,215 pounds of zinc, or an average of 45.17 per cent zinc. A small part came from Blaine County, but most of it came from the Beaver, Hunter, Lelande, Placer Center, and Summit districts of Shoshone County. In 1913 there were 33,178 tons of zinc ore and concentrates containing 27,259,628 gross pounds of zinc, or an average of 41.08 per cent. A notable advance will probably be made in the output of zinc ore and concentrates in 1915.

Zinc ore, lead-zinc ore, and concentrates produced from Idaho mines sold in 1914, with source, by counties, in short tons (dry weight).

County.	Classification.	Quantity.	Average assay of ore and concentrate.[a]
			Per cent.
Blaine and Shoshone	Sulphide zinc ore and concentrates	47,371	45.69
Blaine and Shoshone	Sulphide lead-zinc ore and concentrates.	7,383	41.80
Total		54,754	45.17

[a] Actual zinc content.

REDUCTION PLANTS.

There were 64 milling plants of all kinds in operation in Idaho in 1914, of which many were active for short periods, against 73 active mills in 1913. Of these mills 28 were concentration plants, 13 of which had flotation machines, and 1 used roasting and magnetic separation. Twenty-one mills used amalgamation alone; 6 used cyanidation; 5 amalgamation and concentration; 2 amalgamation, concentration, and cyanidation; 1 amalgamation and cyanidation; and 1 concentration and cyanidation. One lead-smelting plant was in operation a short time at Clayton, in Custer County.

MINING INDUSTRY IN IDAHO IN 1914.

Though Idaho produced much more silver, lead, and zinc than in any previous year, the mining industry of the State was materially affected by the lower prices and unsettled market in the last part of 1914. The Coeur d'Alene region, however, was not so seriously handicapped as other districts of the State nor to the same extent as mining centers in other States. As it produced over 92 per cent of the State output in value, its increase overbalanced the decrease in other sections of the State. It is true that there was some curtailment the latter half of the year, and that two copper mines and one lead mine were closed. But otherwise production proceeded at the normal rate, and more than 33,000 tons of crude ore and concentrates were shipped per month. Moreover, many of the mills have increased their saving by adding various kinds of flotation machines, and several plants have otherwise increased their capacity. The Caledonia mine, whose ores were treated in one of the Bunker Hill mills, made a good production. The Hercules had a record output, and the Interstate-Callahan has developed into an important producer of zinc. Idaho is sixth in the list of zinc-producing States, and in all probability it will soon rank higher. In 1914 Idaho was the second largest producer of silver, Nevada being first, and in output of lead Idaho was second only to Missouri. As the output of siliceous ores decreases, the gold output is upheld by dredge operations. The northern and southern parts of the State are well supplied with railroad facilities, but the central section could be greatly improved by new roads. A branch of the Oregon Short Line from Richfield to Hill City now serves western Blaine County.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1914, by counties.

County.	Gold.				Total value.	Silver.	
	Placers.		Deep mines.				
	Quantity.	Value.	Quantity.	Value.		Quantity.	Value.
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Ada	122.53	$2,533	2.95	$61	$2,594	32	$18
Adams	18.53	383	188.42	3,895	4,278	409	226
Bingham	43.83	906			906	3	2
Blaine	7.16	148	671.01	13,871	14,019	86,234	47,687
Boise	22,866.48	472,692	6,217.88	128,535	601,227	13,441	7,433
Bonner			3.19	66	66	7,144	3,951
Bonneville	190.45	3,937			3,937	4	2
Cassia			.44	9	9	161	89
Clearwater	904.08	18,689	6.43	133	18,822	226	126
Custer	202.69	4,190	2,192.45	45,322	49,512	90,346	49,961
Elmore	463.82	9,588	505.13	10,442	20,030	1,191	659
Fremont			1.79	37	37	18,853	10,426
Gooding	31.01	641			641	2	1
Idaho	982.48	20,310	1,132.33	23,407	43,717	1,084	599
Kootenai	126.74	2,620			2,620	10	5
Latah	33.86	700			700	3	2
Lemhi	7,655.60	158,255	7,146.73	147,736	305,991	71,218	39,383
Nez Perce	.68	14			14		
Owyhee	74.60	1,542	786.09	16,250	17,792	10,952	6,056
Power	33.76	698			698	6	3
Shoshone	99.65	2,060	3,003.94	62,097	64,157	12,178,194	6,734,541
Twin Falls	26.51	548			548	3	2
Total	33,884.46	700,454	21,858.78	451,861	1,152,315	12,479,516	6,901,172

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Ada							$2,612
Adams	31,911	$4,244					8,748
Bingham							908
Blaine	9,089	1,209	1,093,676	$42,653	489,052	$24,942	130,510
Boise	80	11	2,187	85			608,756
Bonner	1,876	250	230,405	8,986			13,253
Bonneville							3,939
Cassia	86	11	518	20			129
Clearwater							18,948
Custer	2,110,909	280,751	341,238	13,308			393,532
Elmore							20,689
Fremont	6,817	907	4,348,831	169,605			180,975
Gooding							642
Idaho	6,457	858					45,174
Kootenai							2,625
Latah							702
Lemhi	35,300	4,695	2,810,722	109,618			459,687
Nez Perce							14
Owyhee			66	3			23,851
Power							701
Shoshone	4,242,662	564,274	339,698,426	13,248,239	41,523,383	2,117,692	22,728,903
Twin Falls							550
Total	6,445,187	857,210	348,526,069	13,592,517	42,012,435	2,142,634	24,645,848

There was a notable increase in placer mining in Lemhi County with a corresponding decrease in Boise County. Placer operations are shown in the following table:

Number of producing placer mines and production in Idaho in 1913 and 1914, by counties.

County.	1913						1914					
	Hydraulic.	Dredge.	Drift.	Gold.	Silver.	Total value.	Hydraulic.	Dredge.	Drift.	Gold.	Silver.	Total value.
				Value.	*Fine ozs.*					*Value.*	*Fine ozs.*	
Ada	3	....	....	$2,018	23	$2,032	5	....	....	$2,533	27	$2,548
Adams	2	....	....	210	2	211	2	....	....	383	3	385
Bingham	4	....	....	1,203	3	1,205	3	....	....	906	3	908
Blaine	1	....	....	35	.....	35	3	....	....	148	1	149
Boise	39	1	....	529,893	6,259	533,673	43	1	1	472,692	5,711	475,850
Bonner	1	....	....	99	2	100	....	....	....	.....	.....	.....
Bonneville	2	....	....	4,548	7	4,552	2	....	....	3,937	4	3,939
Clearwater	25	1	....	10,879	131	10,958	14	1	....	18,689	219	18,811
Custer	5	1	....	3,966	79	4,014	12	....	....	4,190	86	4,237
Elmore	18	....	....	4,624	79	4,672	14	....	....	9,588	135	9,663
Fremont	1	....	....	103	.....	103	....	....	....	.....	.....	.....
Gooding	4	....	....	191	.....	191	1	....	....	641	2	642
Idaho	36	....	5	18,796	183	18,907	64	....	2	20,310	212	20,427
Kootenai	2	....	....	1,744	9	1,749	1	....	....	2,620	10	2,625
Latah	4	....	....	450	6	454	4	....	....	700	3	702
Lemhi	9	3	....	106,714	451	106,986	12	2	....	158,255	620	158,597
Nez Perce	....	....	....	.....	.....	.....	1	....	....	14	.....	14
Owyhee	8	....	....	1,466	21	1,479	4	....	....	1,542	11	1,548
Power	4	....	....	1,192	6	1,196	3	....	....	698	6	701
Shoshone	11	....	1	4,998	46	5,026	9	....	....	2,060	15	2,068
Twin Falls	5	....	....	924	2	925	4	....	....	548	3	550
Total	184	6	6	694,053	7,309	698,468	201	4	3	700,454	7,071	704,364

The deep mines produced less ore, but the value per ton exceeded that of 1913.

Ore sold or treated, number of deep mines producing, and average value of ores in Idaho in 1913 and 1914, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1914	Increase (+) or decrease (−).	1913	1914	1913	1914	1913	1914
	Short tons.	*Short tons.*						
Ada	3	− 2,261	3	1	$0.38	$21.33	$0.38	$21.33
Adams	1,024	+ 850	2	2	87.25	8.17	7.25	4.02
Bear Lake	.....	− 55	3	.....	12.91	.....	.62	.....
Blaine	7,703	− 11,449	42	36	11.11	16.92	3.28	7.99
Boise	17,067	+ 5,584	9	15	8.11	7.79	8.10	7.78
Bonner	458	− 4,553	7	6	7.72	28.94	2.35	8.77
Cassia	14	− 17	2	1	51.48	9.21	21.48	7.00
Clearwater	6	− 14	1	2	15.15	22.83	15.15	22.83
Custer	21,790	− 22,148	14	10	21.48	17.87	4.82	4.37
Elmore	3,239	+ 2,081	3	8	6.91	3.40	6.91	3.40
Fremont	8,267	− 9,956	1	2	20.98	21.89	1.22	1.27
Idaho	4,319	+ 1,663	32	31	11.56	5.73	9.41	5.53
Lemhi	17,550	− 15,106	21	18	22.43	17.16	9.13	10.64
Owyhee	1,641	− 23,904	12	15	8.90	13.59	8.90	13.59
Shoshone	2,152,268	−136,958	36	29	9.07	10.56	2.50	3.16
Total	2,235,349	−216,243	188	176	9.57	10.71	2.72	3.29

[a] Value per ton placer product excluded.

Classifying the deep mines according to metals produced in 1914, it is found that there were 4 mines producing gold only; 79, gold and silver; 17, gold, silver, and copper; 38, gold, silver, copper, and lead; 6, gold, silver, copper, lead, and zinc; 6, gold, silver, and lead; 12, silver and lead; 3, silver, lead, and zinc; 5, silver, copper, and lead; 3, silver and copper; 1, zinc; and 2, gold, silver, lead, and zinc.

REVIEW BY COUNTIES.

ADA COUNTY.

Six properties produced $2,594 in gold and 32 ounces of silver, valued in all at $2,612. The greater part of this output came from the Monitor placer on Boise River in the Highland district.

ADAMS COUNTY.

Four properties produced 1,024 tons of ore, $4,278 in gold, 409 ounces of silver, and 31,911 pounds of copper, valued in all at $8,748, or $8.17 a ton for the ore. Most of the ore was cyanided.

Seven Devils district.[1]—A 50-ton cyanide mill treated ore at the Idaho Gold Coin property, and oxidized copper ore was shipped from the Blue Jacket mine. A large deposit of low-grade copper ore is reported from the Blue Ledge property in Deep Creek Canyon. According to the mine inspector[2]—

> This discovery was made in a 300-foot crosscut tunnel which now discloses an ore body 84 feet thick, of which 30 feet is oxidized ore carrying $7.00 in gold and silver, and 54 feet is massive copper iron sulphide mineral containing average values of 4.6 per cent copper and $5 in gold and silver.

Meadows district.—Placer gold in small quantity was taken from Goose Creek.

BINGHAM COUNTY.

Three placer operators on Snake River reported $906 in gold and 3 ounces of silver. The Eldorado placer near Sterling was worked by rocker.

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[1] Lindgren, Waldemar, Copper deposits of the Seven Devils, Idaho: U. S. Geol. Survey Twentieth Ann. Rept., pt. 3, p. 249, 1900.

[2] Bell, R. N., Mining industry of Idaho: Idaho State Mine Inspector Sixteenth Ann. Rept., p. 27, 1914.

BLAINE COUNTY.

Production of gold, silver, copper, lead, and zinc in Blaine County (Alturas County prior to 1895), Idaho, 1880–1914.

Year.	Gold.		Silver.		Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		*Pounds.*		*Pounds.*		
1880[a]	7,213.00	$149,096	104,628	$120,322							$269,418
1881[a]	8,224.00	170,000	425,400	480,702			1,420,000	$68,160			718,862
1882[a]	8,466.00	175,000	595,560	678,938			4,750,000	232,750			1,086,688
1883[a]	7,256.00	150,000	719,313	798,437			11,600,000	498,800			1,447,237
1884[a]	4,838.00	100,000	1,121,510	1,244,876			10,000,000	370,000			1,714,876
1885[a]	3,995.00	82,585	1,802,709	1,928,899			12,884,930	502,512			2,513,996
1886[a]	10,338.00	213,715	1,490,065	1,475,164			16,464,884	757,385			2,446,264
1887[a]	18,179.00	375,788	1,024,727	1,004,232			20,375,404	916,893			2,296,913
1888[a]	14,513.00	300,000	641,968	603,450			11,000,000	484,000			1,387,450
1889[a b]	2,882.00	59,576	831,300	781,422			7,940,000	309,660			1,150,658
1890[a b]	4,482.00	92,651	673,144	706,801			9,489,020	427,006			1,226,458
1891[a]	2,061.00	42,605	771,774	764,056			8,489,514	365,049			1,171,710
1892[a]	1,102.00	22,780	700,362	609,315			7,703,993	308,160			940,255
1893[a]	824.00	17,033	356,932	278,407			[c] 3,966,606	146,764			442,204
1894[a]	836.00	17,282	294,207	185,350			[d] 2,216,710	73,151			275,783
1895[a]	3,159.00	65,302	150,766	97,998			[d] 1,384,788	44,313			207,613
1896[a]	3,236.00	66,894	260,889	177,405			[d] 3,698,958	110,969			355,268
1897[a]	557.00	11,514	261,654	156,992			[d] 3,283,389	118,202			286,708
1898[a]	537.00	11,101	248,354	146,529			3,725,310	141,562			299,192
1899[a]	1,504.00	31,090	177,854	106,712			2,667,810	120,051			257,853
1900[a]	1,666.00	34,439	157,548	97,680			2,363,220	103,982			236,101
1901[a]	939.00	19,411	99,186	59,512			1,686,162	72,505			151,428
1902[e]	198.00	4,093	200,861	106,456			2,426,289	99,478			210,027
1903[f]	50.00	1,033	334,393	178,599			5,423,027	227,767			407,399
1904[f]	191.00	3,948	488,275	279,537			5,586,119	244,393			527,878
1905[f]	346.00	7,152	374,554	226,230	2,312	$361	3,983,833	187,240	1,084,449	$63,983	484,966
1906[f]	657.84	13,599	184,337	123,506			1,737,605	99,043	10,599	646	236,794
1907[f]	1,311.11	27,103	170,367	112,442	35,919	7,184	2,250,164	119,259	37,077	2,187	268,175
1908[f]	127.23	2,630	126,326	66,953	31,941	4,216	1,675,124	70,355	37,410	1,758	145,912
1909[f]	1,954.45	40,402	115,303	59,958	22,740	2,956	1,762,268	75,777	71,010	3,834	182,927
1910[f]	2,047.95	42,335	92,596	50,002	20,018	2,542	1,284,966	56,539	76,397	4,125	155,543
1911[f]	1,043.55	21,572	47,839	25,355	9,359	1,170	705,545	31,750	29,814	1,699	81,546
1912[f]	901.23	18,630	37,797	23,245	3,516	580	1,819,938	81,897	105,321	7,267	131,619
1913[f]	221.46	4,578	96,626	58,362	10,003	1,550	1,134,320	49,910	1,758,388	98,470	212,870
1914[f]	678.17	14,019	86,234	47,687	9,089	1,209	1,093,676	42,653	489,052	24,942	130,510
Total	116,534.99	2,408,956	15,265,358	13,861,531	144,897	21,768	177,993,572	7,557,935	3,699,517	208,911	24,059,101

[a] Figures of Director of mint. Commercial value of silver substituted and estimate for output of lead added by C. N. Gerry for years for which those figures were lacking.
[b] Combination of Alturas and Logan counties. Lead for 1889 taken from Mineral Resources, 1889, p. 80.
[c] Lead from Mineral Resources, 1893, p. 93.
[d] Lindgren, Waldemar, Wood River mining district: U. S. Geol. Survey Twentieth Ann. Rept., 1898–99, pt. 3, p. 192, 1900.
[e] Totals of U. S. Geol. Survey mine reports retabulated.
[f] Mineral Resources U. S. Geol. Survey, 1904 to 1914.

The output of ore decreased from 19,152 tons in 1913 to 7,703 tons in 1914, but the value per ton increased from $11.11 to $16.92. There were 39 producers, of which 36 were lode mines. These mines produced 3,255 tons of lead ore, 3,228 tons of lead-zinc ore, 613 tons of zinc ore, and 607 tons of siliceous ore. The crude smelting ore amounted to 1,129 tons, valued at $56,682, or $50.21 a ton. The ore concentrated was 5,646 tons, which made 1,353 tons of concentrates, valued at $65,516, or $48.42 a ton. Only 523 tons was treated in gold and silver mills. The district was reviewed in 1900 by Lindgren.[1]

According to the best figures available this county has produced, from 1880 to the end of 1914, gold, silver, copper, lead, and zinc valued at $24,059,101. The main product was silver, valued at $13,861,531; lead was next, valued at $7,557,935; then gold, at $2,408,956; zinc, at $208,911; and copper, at $21,768.

Antelope district.—The Weiler mine produced much oxidized lead ore from a 70-foot shaft.

Hamilton district.—From properties near Clyde there were shipped 136 tons of oxidized lead ore, containing $11 in gold, 2,698 ounces of silver, 101 pounds of copper, and 96,910 pounds of lead. Several shipments came from the Badger Creek and the Clipper mines.

Lava Creek district.—Small shipments of lead ore and silver ore were made from the St. Louis property and the Foot Wall claim.

Mineral Hill district.—Twenty-three deep mines produced 3,910 tons of ore, containing $3,034 in gold, 34,902 ounces of silver, 6,765 pounds of copper, 494,628 pounds of lead, and 404,621 pounds of zinc, valued in all at $63,161, or $16.15 a ton. In 1913 the district produced metals valued at $183,238, largely from old tailings retreated. In 1914 there were 3,462 tons of ore concentrated into 890 tons of concentrates, which were shipped together with 448 tons of crude ore. Many of the producers were merely small lessee operators. In fact, there were only three mines that produced more than 100 tons. The Croesus and the Nay Aug produced lead ore, which was shipped, and ore from the Minnie Moore was concentrated and separated into lead and zinc concentrates. Zinc concentrate was also made from the War Dance ore. The Nay Aug mine was leased by the Big Four Exploration Co. and a 30-ton concentration plant, consisting of crusher, rolls, and tables, was constructed.

Rosetta district.—Tailings and ore were concentrated at the Carrie Leonard property and the King of the West mine into zinc concentrates. The ore deposits of this and other districts in the Sawtooth quadrangle were recently described by Umpleby.[2]

Skeleton Creek district.—The El Oro property was leased and produced bullion by amalgamation. Waterworks were constructed for the Grafter placer, and a bed rock flume at the Jones Bar.

Warm Springs district.—Nearly all the production came from the Independence mine, at which lead ore was concentrated. A high-grade silver-lead ore was also shipped. Ore was also shipped from the Homestake, and concentration tests were made in a 100-ton plant at the Boston-Idaho property. The output of the district was valued at $35,899, against $9,719 in 1913.

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[1] Lindgren, Waldemar, Wood River mining district, Idaho: U. S. Geol. Survey Twentieth Ann. Rept., pt. 3, p. 190, 1900.

[2] Umpleby, J. B., Ore deposits of the Sawtooth quadrangle, Blaine and Custer counties, Idaho: U. S. Geol. Survey Bull. 580, pp. 221–249, 1915.

BOISE COUNTY.

Ore sold or treated in Boise County, Idaho, in 1904–1914, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	
1904	63	17,923	$294,884	38,330	500	.....	$316,891
1905	40	1,788	152,145	1,960	.....	2,064	153,426
1906	57	16,406	229,024	4,909	.....	.....	232,313
1907	68	8,369	235,276	17,553	.....	47,903	249,400
1908	57	15,854	199,307	7,029	198	13,596	203,629
1909	65	8,705	216,031	8,484	2,185	15,410	221,390
1910	68	11,444	199,430	14,443	5,957	3,001	208,117
1911	57	17,376	353,464	7,308	5,354	2,773	358,131
1912	64	9,320	502,277	8,753	1,001	6,106	508,100
1913	49	11,483	620,070	10,942	816	1,376	626,867
1914	60	17,067	601,227	13,441	80	2,187	608,756
Increase (+) or decrease (−) in 1914	.....	+5,584	−18,843	+2,499	−736	+811	−18,111

[a] Includes placer production.

Fifteen deep mines in 1914 produced 17,067 tons of ore, which yielded $128,535 in gold, 7,730 ounces of silver, 80 pounds of copper, and 2,187 pounds of lead, valued in all at $132,906, or $7.79 a ton. In 1913 the deep-mine output was valued at $93,194. Of the tonnage, 17,001 tons were treated in gold and silver mills, largely by amalgamation, and 66 tons were shipped without treatment. All of the ore was siliceous. From the ore milled 257 tons of concentrates were sold, valued at $16,898, or $65.75 a ton. In 1914 there were 45 placer operators, producing $472,692 in gold and 5,711 ounces of silver, a total value of $475,850, against $533,673 in 1913. Dredge operations won most of this placer gold. The geology[1] of this region was described in 1898.

The following table gives the production of gold and silver in this county, exclusive of a small quantity of copper and lead, from 1863 to the end of 1914. By aid of the best estimates at hand for the earlier years it is found that the county has produced nearly $53,097,000 in gold and silver, the greater part of which was produced between 1863 and 1870.

[1] Lindgren, Waldemar, The mining districts of Idaho Basin and Boise Ridge, Idaho: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, pp. 625–736, 1898.

Production of gold and silver in Boise County, Idaho, 1863 to 1914.

Year.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Fine oz.		*Fine oz.*		
1863 [a]	145,125	$3,000,000	50,000	$67,250	$3,067,250
1864 [a]	193,500	4,000,000	70,000	94,150	4,094,150
1865 [a]	241,875	5,000,000	80,000	106,960	5,106,960
1866 [a]	241,875	5,000,000	80,000	107,120	5,107,120
1867 [a]	208,013	4,300,000	70,000	93,100	4,393,100
1868 [a]	208,013	4,300,000	70,000	92,820	4,392,820
1869 [a]	145,125	3,000,000	50,000	66,250	3,066,250
1870 [a]	130,612	2,700,000	40,000	53,120	2,753,120
1871 [a]	96,750	2,000,000	50,000	66,250	2,066,250
1872 [a]	48,375	1,000,000	26,000	34,372	1,034,372
1873 [a]	38,700	800,000	24,000	31,128	831,128
1874 [a]	33,863	700,000	27,000	34,506	734,506
1875 [a]	29,025	600,000	30,000	37,200	637,200
1876 [a]	29,025	600,000	35,000	40,600	640,600
1877 [a]	24,188	500,000	27,000	32,400	532,400
1878 [a]	24,188	500,000	27,000	31,050	531,050
1879 [a]	19,350	400,000	24,000	26,880	426,880
1880 [b]	37,011	765,086	81,025	93,179	858,265
1881 [b]	14,513	300,000	23,203	26,219	326,219
1882 [b]	14,029	290,000	15,469	17,635	307,635
1883 [b]	27,332	565,000	30,938	34,341	599,341
1884 [b]	19,350	400,000	30,938	34,341	434,341
1885 [b]	29,973	619,600	110,702	118,451	738,051
1886 [b]	18,910	390,904	103,945	102,906	493,810
1887 [b]	24,296	502,246	139,109	136,327	638,573
1888 [b]	13,690	283,000	52,246	49,111	332,111
1889 [b]	13,280	274,522	113,376	106,573	381,095
1890 [b]	18,695	386,459	89,002	93,452	479,911
1891 [b]	17,253	356,651	124,325	123,082	479,733
1892 [b]	18,209	376,413	163,368	142,130	518,543
1893 [b]	13,547	280,041	28,896	22,539	302,580
1894 [b]	15,859	327,835	24,876	15,672	343,507
1895 [b]	16,429	339,617	7,954	5,170	344,787
1896 [b]	15,770	325,995	4,645	3,159	329,154
1897 [b]	11,274	233,054	2,811	1,687	234,741
1898 [b]	10,008	206,884	2,685	1,584	208,468
1899 [b]	19,055	393,902	5,681	3,409	397,311
1900 [b]	17,835	368,682	5,068	3,142	371,824
1901 [b]	18,104	374,243	6,325	3,795	378,038
1902 [b]	16,481	340,692	4,770	2,528	343,220
1903 [c]	7,533	155,707	8,432	4,504	160,211
1904 [c]	14,265	294,884	38,330	21,944	316,828
1905 [c]	7,360	152,145	1,960	1,184	153,329
1906 [c]	11,079	229,024	4,909	3,289	232,313
1907 [c]	11,381	235,276	17,553	11,585	246,861
1908 [c]	9,641	199,307	7,029	3,725	203,032
1909 [c]	10,450	216,031	8,484	4,412	220,443
1910 [c]	9,647	199,430	14,443	7,798	207,228
1911 [c]	17,099	353,464	7,308	3,873	357,337
1912 [c]	24,297	502,277	8,753	5,383	507,660
1913 [c]	29,996	620,070	10,942	6,609	626,679
1914 [c]	29,084	601,227	13,441	7,433	608,660
Total	2,460,337	50,859,668	2,092,941	2,237,327	53,096,995

[a] Estimate of gold by Waldemar Lindgren, U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, p. 655, with estimate of silver by C. N. Gerry. Commercial price of silver used throughout.
[b] Director of Mint, 1880 to 1902. Commercial price of silver substituted.
[c] Mineral resources, 1903–1914.

Boise Basin district.—Operators of 9 deep mines and 36 placers produced $595,816 in gold and 8,914 ounces of silver, valued in all at $600,746, against $620,810 in 1913. Deep mines produced 16,918 tons of ore, valued at $126,339, or $7.47 a ton. This tonnage was milled and produced bullion containing 5,263.56 ounces of gold and 1,146 ounces of silver, and 257 tons of concentrates. The placer output was $471,264 in gold and 5,683 ounces of silver. The Boston-Idaho Gold Dredging Co. was the largest producer and treated nearly 5,000,000 cubic yards of gravel in its large dredge on Elk and Moores

creeks. The boat[1] was equipped with 18-cubic-foot buckets, which took the place of those having a capacity of 15 cubic feet. The next largest placer output was made by hydraulicking at the Boise Basin Improvement Co.'s ground. Other important producers were Harwood Glen, Leary & Brogan, Centerville, Native Missourian, and Reid placers. In 1914 a new dredge was constructed to operate on Moores Creek. The Moores Creek Boulder Gold Dredging Co. built a plant with 5½-cubic-foot buckets rated to treat 5,000 cubic yards a day. Of the lode mines, the Gold Hill & Iowa was by far the largest producer. A 50-ton amalgamation mill was run continuously, and bullion was obtained from an ore which averaged about $5 a ton. The next important producer was the Mountain Chief mine of the National M. & D. Co., which was operated for six months. A $25-ore was treated by amalgamation, concentration, and cyanidation in a 25-ton plant. A considerable quantity of rich concentrates went to Salt Lake smelters. Other lode producers were the Golden Age, J. S., and Mohawk.

Deadwood Basin district.—The production consisted of a small output of placer gold and bullion from the Merry Blue and Union mine.

Payette River district.—The Jacobs placer near Van Wyck and other placers on Payette River produced $378 in gold and 8 ounces of silver.

Summit Flat district.—A small production of bullion came from the Golden Chariot property.

West View district.—Four deep mines and 2 placers produced 66 tons of ore, $2,673 in gold, 4,471 ounces of silver, 80 pounds of copper, and 2,187 pounds of lead, valued in all at $5,242. There was little work done compared with that of previous years. The Dewey group produced siliceous gold and silver ore and the Double Eagle property silver ore.

Boise River district.—Small lots of placer gold were taken from the river near Twin Springs.

BONNER COUNTY.

Six deep mines produced 458 tons of ore, 4,553 tons less than was produced by 7 deep-mine operators in 1913. The total average value per ton was $28.94, and the average value of the gold and silver was $8.77. These mines produced $66 in gold, 7,144 ounces of silver, 1,876 pounds of copper, and 230,405 pounds of lead, valued in all at $13,253. Decreased output was general because the Lawrence mine was idle most of the year. Except 27 tons of siliceous ore, all the product was lead ore; 324 tons were concentrated, and 134 tons were shipped without treatment.

Cow Creek district.—One shipment of lead ore came from the Idaho-Montana Amalgamated property near Bonners Ferry. A 50-ton concentration plant was not operated.

Pend Oreille district.—Four mines produced 354 tons, containing $66 in gold, 5,185 ounces of silver, 1,487 pounds of copper, 123,601 pounds of lead, valued in all at $7,951, or $22.46 a ton. Only a few shipments of siliceous silver ore were made, including one from the B. F. H. mine. The Lawrence mine near Clarks Fork produced lead

[1] Miles, J. H., Winter dredging in Idaho: Min. and Sci. Press, Mar. 14, 1914, p. 455.

ore, which was treated in a 50-ton concentration plant, but in April the property was closed; only a few shipments of concentrates had been made. The mill has a United Improved Blake crusher, 2 Caird & Hawksworth rolls, and three No. 5 Wilfley tables.

Priest Lake district.—At the Idaho-Continental property, 26 miles west of Port Hill, the 200-ton concentrator was completed but not operated. Shipments of lead ore went to a Salt Lake smelter. The mill consists of a No. 4 gyratory Blake crusher, 2 rolls 30 by 14, one 6-foot Hardinge pebble mill, hydraulic classifier, Hancock jig, 4 Deister concentrators No. 4, and 2 Deister slimers No. 3.

BONNEVILLE COUNTY.

Placer output was valued at $3,939 from 5 properties.

Mount Pisgah district.—At Gray, hydraulic mining was continued at the American placer and the Barnes group.

CASSIA COUNTY.

Only a small output of ore, carrying gold, silver, copper, and lead, was shipped from Black Pine Mountain, about 25 miles north of Kelton, Utah. Ore has been developed on the Hazel Pine property in the same region.

CLEARWATER COUNTY.

Two unimportant deep mines and 15 placers produced $18,822 in gold and 226 ounces of silver, valued together at $18,948, an increase of $7,643 in gold and of 91 ounces of silver.

Burnt Creek district.—The production was small, consisting of placer gold from the Boise and Grubstake placers and a sample of ore from the Last Chance property.

Pierce district.—Eleven placers and 1 deep mine produced $17,088 in gold and 200 ounces of silver, against $10,013 in gold and 120 ounces of silver in 1913. Most of these operators contributed small outputs. The Idaho Power Co. (Ltd.) produced most of the output by a dredge which has 3½ cubic foot buckets. This plant was active six months, having been rebuilt after a fire. A new dredge was under construction in the district to operate on the Custer, Poorman, and Black Bess property along Oro Fino Creek 5 miles from Pierce. The plant is of the Risdon type, having 3¼ cubic foot buckets and a theoretical capacity of 2,000 cubic yards a day, or an actual average daily capacity by the year of about 1,200 cubic yards. At the Oro Grande and Hay Creek placers fair productions were made by hydraulicking.

CUSTER COUNTY.

Ten deep mines produced 21,790 tons of ore, 22,148 tons less than was produced by 14 operators in 1913. The total value per ton was $17.87 and the value per ton in gold and silver was $4.37. The output decreased $554,408 in total value and all the metals decreased in quantity. The output of the county, including the output of 12 placers, was $49,512 in gold, 90,346 ounces of silver, 2,110,909 pounds of copper, and 341,238 pounds of lead, valued in all at $393,532. The

ore was classified as 17,814 tons of copper ore, 3,010 tons of siliceous ore, and 966 tons of lead ore. Nearly all the ore, or 18,790 tons, was shipped to smelters without treatment. Gold and silver mills treated 500 tons of ore and 2,500 tons of old tailings, and produced bullion valued at $22,704.

Alder Creek district.—Two mines produced copper ore and lead ore having a total value of $334,476, a decrease from $721,315 in 1913. Several shipments of lead ore came from the Carbonate property, and all the copper ore came from the Empire property. This mine, however, had only half the production of 1913. About one-third of the ore shipped in 1914 was oxidized. The smelter was idle and the ground was worked by lessees. The deepest tunnel work is on the 900-foot level. A 3,000-foot lower tunnel will afford 900 feet additional depth on the ore shoots. This tunnel must be carried 1,400 feet farther to get under the developed ore bodies. In addition to the sulphide ore there is a large quantity of carbonate ore which may prove valuable if leached.

Bayhorse district.—Six deep mines produced 885 tons of ore, $85 in gold, 20,836 ounces of silver, 4,468 pounds of copper, and 312,668 pounds of lead, valued in all at $24,395, or $27.56 a ton. In 1913 five mines produced 3,525 tons of ore, valued at $100,251. The Red Bird Smelting Co. owns a new and incomplete plant of 100 tons' capacity and the old plant, which was only operated a few weeks in 1914. Part of the property was leased and a few shipments were made to Salt Lake smelters.

Loon Creek district.—The Loon Creek Hydraulic Mining Co. was engaged in prospecting placer grounds and constructing a flume in 1914. The Lost Packer copper matting plant was idle in 1914, but mining was continued on the property. Several hundred tons of chalcopyrite ore, valued at $65 a ton, was taken out for future smelting. No ore was shipped. The idleness of this plant made a considerable decrease both in the gold output of the county and in the total output of copper, because the ore contains more than 2 ounces of gold a ton. A report[1] on the property was published by the Survey in 1913.

Stanley Basin district.—Six small placer operations reported $2,881 in gold and 68 ounces of silver. Joe's Gulch was the largest producer, but the output was far below that of former years. The dredge of the Willis Co. was not active.

Yankee Fork district.—Two deep mines and five placers produced $26,366 in gold and 9,562 ounces of silver, valued in all at $31,654. A large part of this production came from the Montana mine, developed to a depth of 500 feet. The ore was treated by amalgamation and concentration, and some rich ore was shipped. The output contained 9 ounces of silver to 1 of gold, a higher average than in former years when the mine is said to have produced $337,000, principally in gold. Tailings from the Golden Sunbeam mine were treated by cyanidation. From 1904 to 1910 this property produced several thousand ounces of gold annually. The bullion then contained 1 ounce of silver to each ounce of gold.

[1] Umpleby, J. B., Some ore deposits of northwestern Custer County, Idaho: U. S. Geol. Survey Bull. 539, 1913.

ELMORE COUNTY.

Eight deep mines produced 3,239 tons of ore, 2,081 tons more than three operators produced in 1913. The ore contained gold and silver and was valued at $3.40 a ton. The total output of the county was $20,030 in gold and 1,191 ounces of silver. This included the output of 14 placers, which was $9,588 in gold and 135 ounces of silver. The total value increased from $12,672 in 1913 to $20,689 in 1914. In 1911 the output was valued at $248,230. All the ore was siliceous and nearly all was treated in gold and silver mills, principally by cyanidation.

Bear Creek district.—Five placer operators produced $5,571 in gold and 91 ounces of silver. The Elmore Placer Co., on Feather River, was the only important operator. The deposit is worked by hydraulicking in conjunction with an elevator.

Black Warrior district.—A little rich gold ore was shipped from the Little Boise and King claims.

Highland district.—A small placer output came from the Last Chance claim, near Twin Springs.

Middle Boise district.—The Minerva and Atlanta mines were not productive, but the mill of the Bagdad Chase was run a few days on ore from a new vein. Amalgamation and concentration were used, the cyanide plant being idle. An Evans elevator with hydraulic mining was used on the Boise King placer, 18 miles from Atlanta.

Neal district.—The Homestake mine was only operated a short time through lessees. Bullion from the cyanide mill was shipped, but not enough to make the work profitable.

Pine Grove district.—Some cyanide bullion came from the Franklin mine, which was worked for a time by lessees.

Snake River district.—The Edna placer, 3 miles southeast of King Hill, was worked by sluicing, and about 2,000 cubic yards of gravel was handled.

Twin Springs district.—Five placers produced $1,275 in gold and 16 ounces of silver from the south bank of Boise River.

Volcano district.—A trial shipment of silver ore was made from the Bower prospect, near Hill City.

FREMONT COUNTY.

The output of the county came from the Scott mine, in the Birch Creek district, and the Wilbert property, in the Dome district. The former mine shipped lead carbonate containing a little silver. The Wilbert mine and 100-ton concentration mill were operated for about six months and produced lead concentrates and a first-class selected ore, which is picked from the belt as the ore goes through the mill. The output was less than half of that for the year 1913 on account of the price of lead. The ore contains only a few ounces of silver per ton. The report of the operations of the company [1] for the 12 months ending May 1, 1915, is, in part, as follows:

> During the period mentioned 7,522 tons of ore were mined. Of this tonnage 6,685 tons were milled, 657 tons were shipped crude, and 180 tons of mill ore were stored on No. 3 dump, awaiting the resumption of mill operations. The

[1] Wilbert Mining Co. Rept. for 12 months ending May 1, 1915.

mill ore averaged 30.3 per cent lead and 2.5 ounces silver per ton. The 657 tons of crude ore shipped averaged 55.81 per cent lead and 8.69 ounces silver. This tonnage came from the following stopes: No. 2 stope, 3,520 tons; No. 4 stope, 3,016 tons; No. 5 stope, 986 tons; making a total of 7,522 tons. The cost of extraction was $21,617.11.

The main development during the past year has been the continuation of the inclined shaft to the No. 5 level, cutting out of ore and waste pockets, drifting on the vein on both No. 4 level and No. 5 level, and crosscutting in the Wilbert hill. A total of 844 feet has been driven at a cost of $9,571.92. Most of the work, such as the sinking of the shaft and the drifting on No. 4 and No. 5 levels, which were timbered preparatory to stoping, has been of an expensive nature. Our main ore shoot on No. 4 level proved to be 190 feet long with an average width of 2 feet 6 inches. The ore on this level had an average grade of 35 per cent lead and 2.5 ounces silver, but in stoping above this level, the ore became somewhat lower in grade. On No. 5 level this same ore shoot was 110 feet long with an average width of 1 foot 3 inches. The grade of the ore, however, proved to be between 40 per cent and 45 per cent lead with about 8 ounces of silver. In stoping above this level the ore has maintained the same lead contents, but the silver values decreased somewhat. However, the ore in this stope has maintained a better width than it showed on the level. No sinking has been done below the No. 5 level.

The mill was in operation during the past 12 months a little less than five months, due principally to the prevailing low price of lead. The 6,685 tons of ore milled produced 3,035.73 tons of product assaying 53.79 per cent lead and 4.56 ounces of silver per ton; the ratio of concentration being 2.22 tons into 1. The lead recovery was 80.7 per cent and the silver recovery 83.0 per cent. The cost of milling was $1.73 per ton. Operations at the mill will be resumed June 1, it being the intention to operate day shift only.

The deposit was described by Umpleby in 1914.[1]

GOODING COUNTY.

The Big Body placer, near Clearlake, on Snake River produced fine gold by sluicing.

IDAHO COUNTY.

Ore sold or treated in Idaho County, Idaho, in 1904–1914, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	
1904	52	36,367	$301,478	6,760	.....	.....	$305,348
1905	45	28,181	217,943	5,159	.....	.....	221,059
1906	47	18,130	171,030	8,929	.....	.....	177,012
1907	59	13,427	110,747	2,180	3,043	.....	112,795
1908	68	15,778	192,934	9,907	233	.....	198,216
1909	57	25,765	205,212	7,421	.....	.....	209,071
1910	82	6,351	63,885	1,744	.....	.....	64,827
1911	65	7,147	75,296	1,338	312	.....	76,044
1912	75	4,948	82,182	1,117	.....	82	82,873
1913	73	2,656	42,637	2,091	36,831	.....	49,609
1914	97	4,319	43,717	1,084	6,457	.....	45,174
Increase (+) or decrease (−) in 1914	.....	+1,663	+1,080	−1,007	−30,374	.....	−4,435

[a] Placer production included.

Thirty-one deep-mine producers in 1914 produced 4,319 tons of ore, 1,663 tons more than was produced by 32 operators in 1913. The total average value per ton of the ore decreased from $11.56 in 1913 to $5.73 in 1914, and the gold and silver value from $9.41 to $5.53.

[1] Umpleby, J. B., Lead-silver deposits of the Dome district, Idaho: U. S. Geol. Survey Bull. 540, pp. 212–222, 1914.

The total value of the county production, including the output of 66 placers, was $43,717 in gold, 1,084 ounces of silver, and 6,457 pounds of copper, valued in all at $45,174. Of this total the placer output was $20,310 in gold and 212 ounces of silver. With the exception of 43 tons of copper ore, the entire tonnage was siliceous in character, and 4,240 tons were treated in gold and silver mills, by either amalgamation or cyanidation. There were 79 tons shipped directly to smelters.

Big Creek district.—No output was reported, but an article[1] on the region appeared in July, 1914.

Camp Howard district.—Four small placer operators produced $1,037 in gold and 8 ounces of silver. The Cape Horn placer at White Bird was one of these operators.

Clearwater district.—Four placers and 1 deep mine produced $2,486 in gold, 47 ounces of silver, and 1,126 pounds of copper, valued in all at $2,661. The Sims lode mine in the Kincaid camp produced a shipment of siliceous gold ore. The property is 6 miles east of Grangeville.

Cottonwood district.—A small quantity of oxidized copper ore was shipped from the Great Eastern mine.

Dixie district.—Five deep mines and 3 placers produced 56 tons of ore, $1,677 in gold, and 33 ounces of silver, valued in all at $1,694. Small quantities of ore were treated from the Diamond, Monmouth, Northern Star, and Penn Dixie mines.

Elk City district.—Ten deep mines and 11 placers produced 591 tons of ore, $14,446 in gold, 194 ounces of silver, and 87 pounds of copper, valued in all at $14,564. The placers produced $4,930 in gold and 33 ounces of silver. The deep-mine producers were the Black Pine, Del Rio, Grangeville, Hope, Last Chance, Mineral Zone, and Gold Rock. No mills were operated continuously and the placer production was comparatively small. The Buster mine remains idle, as development on the 400-foot level was not considered encouraging. The Elk City Dredging Co. did not operate, but the dredge is to be remodeled.

Florence district.—Five placer operators produced $1,129 in gold and 9 ounces of silver. The Last Chance, Buttercup, Gold Lake, and Strobe placers were operated slightly. This district was discovered in 1861 and made its greatest production between that date and 1868, when the output began to decline. The total production is not known, but is variously estimated between $15,000,000 and $30,000,000. A short account[2] of the region appeared in 1900.

Maggie Creek district.—Three placers produced $460 in gold and 7 ounces of silver.

Marshall Lake district.—The Three Mile placer, 2½ miles north of Resort, was operated by hydraulicking.

Newsome district.—One deep mine and 3 placers produced only $520 in gold and 3 ounces of silver.

Orogrande district.—Two placers and 2 deep mines produced $5,010 in gold and 112 ounces of silver, valued in all at $5,072. A test run was made at the old Crooked River property by cyanidation, and ore was amalgamated from the Syringa mine, a new property.

[1] Big Creek mining district, Min. and Sci. Press, July 18, 1914, p. 110.
[2] Lindgren, Waldemar, Florence gold-mining district: U. S. Geol. Survey Twentieth Ann. Rept., pt. 3, p. 232, 1900.

Profile district.—Small trial shipments of siliceous gold ore and siliceous silver ore were made from various prospects in the district, including the Red Metal and Victor properties.

Robbins district.—A small quantity of bullion from cyanide operations was shipped from the Old Jumbo mine.

Simpson district.—Nine placer operators produced $1,925 in gold and 13 ounces of silver.

Salmon River district.—Small lots of placer gold were shipped from the Monarch and other claims 15 miles south of Dixie.

Tenmile district.—Four deep mines and 5 placers produced $6,480 in gold and 82 ounces of silver, valued in all at $6,526. Bullion was won by amalgamation at the Buckhorn and the Wander properties. The largest placer production came from the Tippie claim.

Thunder Mountain district.—The only production from this region, amounting to $2,107 in gold and 64 ounces of silver, came from placering the old dumps at the Sunnyside and Dewey mines.

Warren district.—Two deep mines and 9 placers produced $3,362 in gold and 38 ounces of silver. The mines were all small producers, except the Blue Bird and the Gold Dollar placers. The camp was discovered in 1862, and most of the production, which is estimated at $15,000,000 in placer gold, came soon after that date. A brief description[1] of the camp was published in 1900.

KOOTENAI COUNTY.

Near Tyson, the Cedar Creek property was operated from May until the end of the year, and about 44,000 yards of material were treated by the hydraulic method.

LATAH COUNTY.

A small output of placer gold came from the Gold Creek and the Hoodoo districts.

LEMHI COUNTY.

Ore sold or treated in Lemhi County, Idaho, in 1904–1914, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	
1904	34	31,746	$251,948	44,475	5,000	1,827,400	$357,984
1905	19	17,271	98,171	39,357	.....	1,796,000	206,355
1906	20	17,466	105,932	36,453	40,000	1,144,000	203,284
1907	36	12,527	84,212	50,572	52,461	1,932,356	230,496
1908	37	2,515	72,682	22,992	10,366	700,622	115,662
1909	17	19,827	129,808	5,675	46,246	132,071	144,450
1910	35	15,392	66,961	150,185	54,887	6,526,474	442,197
1911	32	35,065	121,189	383,039	390,660	16,854,922	1,131,503
1912	40	45,640	225,473	348,993	106,014	16,965,603	1,221,048
1913	33	32,656	276,306	213,239	60,323	9,659,763	839,482
1914	32	17,550	305,991	71,218	35,300	2,810,722	459,687
Increase (+) or decrease (−) in 1914	.....	−15,106	+29,685	−142,021	−25,023	−6,849,041	−379,795

[a] Includes placer production.

[1] Lindgren, Waldemar, Warren gold-mining district: U. S. Geol. Survey Twentieth Ann. Rept., 1898–99, pt. 3, p. 237, 1900.

Eighteen deep mines produced 17,550 tons of ore, 15,106 tons less than was produced by 21 operators in 1913. The average value per ton of the ore decreased from $22.43 to $17.16, but the average value in gold and silver alone increased from $9.13 to $10.64. The lead mines of the Gilmore camp were affected to a great extent by the conditions of the metal market. Fourteen placers produced $158,255 in gold and 620 ounces of silver, valued in all at $158,597. This production was principally that of placers operated by dredges. Of the total output, 12,572 tons were siliceous ore, 4,935 tons lead ore, and 43 tons copper ore. In 1913 the output of lead ore was 18,185 tons. There were 6,691 tons treated at gold and silver mills and 10,249 tons were shipped directly to smelters. Bullion recovered by amalgamation and cyanidation was valued at $64,253, or $9.60 a ton. The districts of this county were reviewed in a recent Survey publication.[1]

Blackbird district.—The Ludwig mine of the Musgrove Mining Co. produced considerable bullion through the operation of a 17-ton cyanide plant, which was active about three months in 1914. The plant consists of a Dodge crusher, one 10-foot Lane mill, a classifier, and two Trent agitators.

Blue Wing district.—The Castle Rock mine made a small shipment of sulphide copper ore.

Carmen Creek district.—Ore was treated by amalgamation at both the Carmen Creek property and the Oro Cache mine. These operations were carried on principally for testing purposes.

Eldorado district.—At Bohannon Bar, 12 miles from Salmon, the new dredge of the Bohannon Dredging Co. was operated for seven months. The plant is equipped with buckets having a capacity of 6 cubic feet, and 613,000 cubic yards of material are said to have been handled during the year.

Eureka district.—Two deep mines and five placers produced 55 tons of ore, $1,961 in gold and 17 ounces of silver, valued in all at $1,970. The Mullen dredge was not operated during the year. Small quantities of ore were treated at the U. P. & Burlington property and the Wickham mine. Some placer bullion was produced at the Hawkeye property, 14 miles from Salmon.

Gravel Range district.—Ore was tested by amalgamation at the Rabbit Foot property, near Forney, during August, September, and October, 1914.

Gibbonsville district.—The Belcher Bar and the Hughes Creek placers were operated by sluicing and hydraulicking. The A. D. M. & R. Co.'s property, whose mine plant was burned the latter part of 1913, was not productive.

Indian Creek district.—The Kittie Burton & Ulysses property was operated exclusively by lessees during the year. Considerable ore was treated, principally by amalgamation and partly by cyanidation. This property is the largest deep-mine bullion producer in the county.

Junction district.—A shipment of lead ore was made from the Leadville group and a shipment of oxidized copper ore was made from the Patton mine.

Kirtley Creek district.—One of the most important operators in the county was the Kirtley Creek Gold Dredging Co., which operated a

[1] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528, 1913.

placer property 289 days during the year, handling over 1,000,000 cubic yards of material in the large dredge.

Mackinaw district.—Three placers in this district produced $2,765 in gold and 27 ounces of silver, valued in all at $2,780. The Richardson placer near Leesburg was the main producer.

McDevitt district.—The Copper Queen mine, near Tendoy, produced a small shipment of sulphide copper ore, which was shipped to Montana.

Mineral Hill district.—A small quantity of ore from the Clipper Bullion mine was treated by amalgamation as a test.

Texas district.—Four deep mines produced 10,165 tons of ore, $84,079 in gold, 68,442 ounces of silver, 23,362 pounds of copper, and 2,793,327 pounds of lead, having a total value of $233,975, or $23.02 a ton. This was a marked decrease from the production of 1913, when 21,905 tons of ore were produced, having a total value of $621,385. There was a similar falling off in production at the Pittsburg-Idaho property, which shipped a little over 200 tons a month instead of 800 or 900 tons a month, as in 1913, and about 2,000 tons a month as in 1912. There was also a considerable decrease at the Latest Out property. The Allie Mining Co. and the Gilmore Mining Co. both shipped a considerable quantity of oxidized iron ore containing gold and silver. A few shipments were made from the Allie property in the early part of the year. The vein was said to be 4½ feet wide and it was reported that 18 inches of it assayed $1,375 a ton in gold.

Yellow Jacket district.—Some old tailings from the Mandarin property were cyanided during the year, and the product was shipped east. Some placer gold was also produced from the Barkhart property. The Mandarin Mines Corporation has the old Yellow Jacket property, including the mill built in 1896. This plant has a capacity of 150 tons and has 1 Blake and 1 Gates crusher, 60 stamps of 850 pounds each, and 6 vats of 45 tons each.

NEZ PERCE COUNTY.

Sluicing was carried on at the Homestead Entry property in the Clearwater district.

OWYHEE COUNTY.

Fifteen deep mines produced 1,641 tons of ore, a decrease of 23,904 tons from the output by 12 operators in 1913. The average value per ton of the ore was $13.59 in gold and silver, against $8.90 in 1913. The total production of the county, including the output of 4 placers, was $17,792 in gold, 10,952 ounces of silver, and a few pounds of lead, in all valued at $23,851. This is a marked decrease from the production of 1913, valued at $228,914, which, in turn, was a decrease from the production of 1912, value at $417,967. The decrease was notable when the Trade Dollar mine ceased to operate, and now that the De Lamar property is practically unproductive, the county totals are still further diminishing. All the ore was siliceous in character and, with the exception of 1 ton which was shipped to a smelter, was treated in gold and silver mills, principally by amalgamation. The placer output was $1,542 in gold and 11 ounces of silver.

The production of gold and silver in Owyhee County from the year of earliest output to the end of 1914 is given in the following table. A small production of copper and lead was made, but is not included in this table. In the last 10 years the production has been steadily declining. The total output of gold is valued at $21,569,308 and with 24,297,729 fine ounces of silver having an aggregate commercial value of $18,727,206, the county output of gold and silver has a total value of $40,296,514. With the exception of the early years when the placer output was the largest, the period of greatest productivity seems to have been from 1890 to 1901, when the county produced considerably more than $1,000,000 annually.

Production of gold and silver in Owyhee County, Idaho, 1863–1914.

Year.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Fine oz.		*Fine oz.*		
1863–1866[a]	145,125	$3,000,000	746,826	[b] $1,000,000	$4,000,000
1867[c]	37,491	775,000	169,173	225,000	1,000,000
1868[c]	50,794	1,050,000	263,952	350,000	1,400,000
1869[c]	51,761	1,070,000	400,000	530,000	1,600,000
1870[c]	20,317	420,000	318,475	422,935	842,935
1871[c]	23,704	490,000	370,840	491,363	981,363
1872[c]	10,981	227,000	172,585	228,157	455,157
1873[c]	24,236	501,000	386,482	501,267	1,002,267
1874[c]	21,769	450,000	352,113	450,000	900,000
1875[c]	5,442	112,500	90,726	112,500	225,000
1876–1879[a]	24,187	500,000	434,783	500,000	1,000,000
1880[d]	2,864	59,205	99,560	114,495	173,700
1881[d]	2,419	50,000	208,833	235,981	285,981
1882[d]	9,675	200,000	177,895	202,800	402,800
1883[d]	7,256	150,000	154,691	171,707	321,707
1884[d]	4,837	100,000	154,691	171,707	271,707
1885[d]	6,528	134,940	33,617	35,970	170,910
1886[d]	3,318	68,588	34,377	34,033	102,621
1887[d]	4,397	90,883	5,763	5,648	96,531
1888[d]	5,578	115,304	18,807	17,679	132,983
1889[d]	12,260	253,436	338,071	317,787	571,223
1890[d]	16,556	342,243	767,397	805,767	1,148,010
1891[d]	16,254	336,000	705,568	698,512	1,034,512
1892[d]	23,244	480,496	645,569	561,645	1,042,141
1893[d]	25,344	523,906	811,835	633,231	1,157,137
1894[d]	37,915	783,773	1,004,792	633,019	1,416,792
1895[d]	35,204	727,731	1,297,814	843,579	1,571,310
1896[d]	32,948	681,095	1,428,237	971,201	1,652,296
1897[d]	33,666	695,938	1,238,045	742,827	1,438,765
1898[d]	34,275	708,527	1,320,210	778,924	1,487,451
1899[d]	34,001	702,863	976,817	586,090	1,288,953
1900[d]	37,538	775,979	1,006,212	623,851	1,399,830
1901[d]	38,912	804,382	1,065,167	639,100	1,443,482
1902[d]	20,938	432,827	698,574	370,244	803,071
1903[e]	19,665	406,475	762,604	407,307	813,782
1904[e]	23,584	487,524	802,290	459,311	946,835
1905[e]	14,866	307,308	846,042	511,009	818,317
1906[e]	9,491	196,234	737,578	494,177	690,411
1907[e]	17,218	355,919	793,942	524,002	879,921
1908[e]	18,862	389,915	857,537	454,495	844,410
1909[e]	20,574	425,305	647,397	336,646	761,951
1910[e]	18,805	388,728	341,494	184,406	573,134
1911[e]	15,586	322,203	291,133	154,301	476,504
1912[e]	14,030	290,036	207,850	127,828	417,864
1913[e]	8,139	168,253	100,413	60,649	228,902
1914[e]	861	17,792	10,952	6,056	23,848
Total	1,043,415	21,569,308	24,297,729	18,727,206	40,296,514

[a] Lindgren, Waldemar, U. S. Geol. Survey Twentieth Ann. Rept., 1898–99, pt. 3, p. 111—Estimate, with an approximate separation of gold and silver.
[b] Commercial price of silver used throughout.
[c] Raymond, R. W., Mineral Resources West of Rocky Mountains, 1870 to 1876, with an estimate of the separation of gold and silver.
[d] Director of Mint, Ann. Repts. Commercial price of silver substituted.
[e] Mineral Resources, 1903–1914.

Carson district.—Nearly all the output of the county came from this district. There were 13 deep mines and 1 placer producing, having a total output of 1,611 tons of ore, $14,496 in gold, 10,621 ounces of silver, and 66 pounds of lead, valued in all at $20,372. Although the De Lamar mine is no longer operated as formerly, some ore was extracted in prospecting, and cyanide bullion and a few tons of concentrates were marketed. At the Sunnyside or Bergh property several hundred tons of ore were treated by amalgamation. Some rich ore was treated from the Ruth property, and small lots of ore from various properties were treated at the Addie custom mill. Development work was done all the year by the Silver City Mining & Milling Co., and the mill in Long Gulch, half a mile southeast of Silver City, was remodeled. It consists of 10 stamps, tube mill, classifiers, concentration tables, and a 25-ton cyanide plant. This plant will contribute to the production of 1915.

French district.—At the old Cumberland property a clean-up was made around the old mill. A new property, called the Tango, 2½ miles east of Silver City on War Eagle Mountain, produced a small quantity of ore, which was treated at a custom mill.

Snake River district.—Three placers produced $1,400 in gold and 9 ounces of silver, valued in all at $1,405. The Sailor Creek placer was one of the producers.

POWER COUNTY.

This county, which was made up from parts of Oneida and Lincoln counties, produced a small output of placer gold from the Golden Clift and the Rosecrans properties.

SHOSHONE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Shoshone County, Idaho, in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	48	2,289,226	$81,749	9,337,109	5,097,894	296,740,946	21,415,565	$20,767,410
1914	38	2,152,268	64,157	12,178,194	4,242,662	339,698,426	41,523,383	22,728,903
Increase (+) or decrease (−) in 1914.		−136,958	−17,592	+2,841,085	−855,232	+42,957,480	+20,107,818	+1,961,493

[a] Includes placer production.

This county is notable for the Coeur d'Alene region, which includes several mining districts mentioned below. Twenty-nine deep mines produced 2,152,268 tons of ore, or 136,958 tons less than was produced by 36 deep-mine operators in 1913. However, the average total value per ton of the ore increased from $9.07 in 1913 to $10.56 in 1914, and the value per ton in gold and silver from $2.50 to $3.16. The output of the county was valued at $22,728,903, which is more than 92 per cent of the value of the State output and was an increase of $1,961,-

493. Gold and copper are the only metals the value of whose output decreased. Silver increased 2,841,085 ounces in quantity and $1,094,927 in value; lead increased 42,957,480 pounds in quantity but only $191,637 in value on account of the decreased price; zinc (spelter) increased 20,107,818 pounds in quantity and $918,421 in value. The county produced principally lead ore and lead-zinc ore. Of the lead ore there were 1,404,039 tons, and of the lead-zinc ore 665,202 tons. The output of copper ore was 75,046 tons and of zinc ore 7,860 tons. The larger part of all this ore, or 2,054,121 tons, was concentrated, and, with 100 tons of old tailings, made 299,189 tons of concentrates, containing 2,169.84 ounces of gold, 8,781,540 ounces of silver, 3,234,374 pounds of copper, 262,831,540 pounds of lead, and 34,450,175 pounds of zinc, having a total value of $17,338,608, or an average value per ton of $57.95. These concentrates were made up of 5,029 tons of copper concentrates and 248,979 tons of lead concentrates from lead ore and lead-zinc ore, which contained 2,101.24 ounces of gold, 8,570,706 ounces of silver, 1,004,992 pounds of copper, and 261,298,466 pounds of lead; 38,677 tons of zinc concentrates from lead-zinc ore, containing 29,905,945 pounds of zinc; and 6,504 tons of lead-zinc concentrates from lead-zinc ore, containing 4,544,230 pounds of zinc. Crude ore shipped to smelters amounted to 97,935 tons, containing $16,009 in gold, 3,396,620 ounces of silver, 1,008,288 pounds of copper, 76,866,886 pounds of lead, and 7,073,208 pounds of zinc, valued in all at $5,386,985, or $55.01 a ton. Separated into its various kinds, there were 6,552 tons of copper ore, containing 23.32 ounces of gold, 37,226 ounces of silver, and 599,940 pounds of copper; and 82,663 tons of lead ore, containing 736.10 ounces of gold, 3,345,121 ounces of silver, 408,348 pounds of copper, and 76,761,657 pounds of lead. There were 7,860 tons of crude zinc ore shipped, containing 6,423,321 pounds of zinc, which, with a small quantity of lead-zinc ore and siliceous ore, made up the total. Nine placer operators produced $2,060 in gold and 15 ounces of silver, valued in all at $2,068.

For several months of the year 1914 shipments of the various mines were published, but as the figures are not complete for the whole year, one month's shipments[1] of crude ore and concentrates are given to show the comparative activities of the mines in May, 1914:

Shipments of ore from mines in the Coeur d'Alene region in May, 1914.

	Short tons.		Short tons.
Hercules	7,000	Gold Hunter	1,020
Bunker Hill and Sullivan	5,500	Ontario	750
Morning (23 days)	4,500	Marsh	500
Green Hill-Cleveland	3,300	Snow Storm	1,015
Stewart	3,500	National Copper	300
Interstate-Callahan	2,800	Crown Point	100
Hecla	2,000	Caledonia	200
Last Chance	2,000	Yankee Boy	50
Tamarack and Custer	1,700		
Sierra Nevada	1,200	Total	38,820
Success	1,385		

[1] Min. and Sci. Press, June 20, 1914, p. 1030.

Production of gold, silver, copper, lead, and zinc in the Coeur d'Alene region, Shoshone County, Idaho, 1884–1914, by periods.

Period.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Value.	*Fine ounces.*	*Pounds.*	*Tons.*	*Pounds.*	
1884–1890	$1,521,166	3,605,174	.....	60,480	.....	$10,198,024
1891–1900	2,746,172	28,240,330	.....	434,309	.....	55,383,115
1901–1910	846,115	62,760,820	44,212,102	1,046,354	15,954,370	141,639,156
1911	86,035	7,383,899	2,926,551	127,419	8,310,435	16,306,680
1912	84,430	7,558,314	4,386,403	132,276	13,800,181	18,313,604
1913	81,749	9,337,109	5,097,894	148,370	21,415,565	20,767,410
1914	64,157	12,178,194	4,242,662	169,849	41,523,383	22,728,903
Total	5,429,824	131,063,840	60,865,612	2,119,057	101,003,934	285,336,892

Since the beginning of mining in this region in 1884 the county has produced gold, silver, copper, lead, and zinc valued at $285,336,892. The production of lead has been of first importance, with the production of silver, copper, gold, and zinc secondary.

Beaver district.—Two deep mines and 2 placers produced 89,164 tons of ore, $750 in gold, 39,884 ounces of silver, 1,895,649 pounds of lead, and 23,930,359 pounds of zinc, valued in all at $1,317,182. Placer mining near Delta has been declining for the last few years. From the Idora Hill property a few hundred tons of lead ore were concentrated in a 75-ton mill and lead concentrates were shipped to the smelter. The Consolidated Interstate Callahan Mining Co., owning property in both Beaver and Placer Center districts, has become Idaho's largest zinc producer. The mill treated about 250 tons of ore a day, and about 700 tons of first-class lead ore and zinc ore were shipped a month. Altogether about 30,000 tons of crude ore and concentrates were marketed, of which only about 5 per cent was lead ore or concentrate. At the close of the year the mill and the hauling facilities were found inadequate to the mine output, and plans were in progress for increasing the capacity of the mill and constructing a tramway from the mill to the railroad. Flotation machines were added late in the year and were reported to have improved the mill extraction about 10 per cent. The company is developing on the No. 4 level an ore shoot, reported to be 1,200 feet long and ranging from 20 to 50 feet wide. A shaft was sunk 450 feet from this level, and after crosscutting, the shoot was said to be 8 feet wide. In October the mill had a crushing capacity of 300 tons, with 3 sets of rolls, a 6-foot Hardinge mill, 6 Callow tanks, and 5 flotation machines. Ore and concentrates are hauled 2 miles to Sunset, on the branch of the Northern Pacific, at a cost of $1.25 a ton. Indications are that this company will be a much larger producer of zinc in 1915. In the first quarter of 1915 shipments amounted to 12,000 tons. According to the statement of the assessor for 1914, 88,664 tons of ore extracted were from the Interstate-Callahan mine, which had a gross value of $828,961. Cost of extraction was $313,003; freight and treatment, $318,143; betterment and repairs, $10,752; and net profit, $187,063. The dividend record did not begin until 1915. Development at the Sunset mine continued, and tests on the lead and zinc ore were made at the Elm Orlu mill at Butte, Mont.

Coeur d'Alene district.—From this district near Murray a small output of gold ore was treated from the Winnie and Frieda claims.

Eagle district.—At the Eagle placer, belonging to Dunlap & Smith, the pay streak was lost and very little gold was produced during the year.

Evolution district.—A considerable output of sulphide lead ore, containing high percentages of silver, was shipped from the Yankee Boy mine by a lessee. A sample shipment gave the following assays: 0.02 ounce of gold, 123 ounces of silver, 0.8 per cent copper, 8.4 per cent lead, 48.6 per cent insoluble, 14.1 per cent iron, and 2.9 per cent sulphur. According to the statement of the assessor, 358 tons of ore were extracted from the Yankee Boy (Lease), which had a gross value of $38,646. Cost of extraction was $22,057; freight and treatment, $4,192; betterment and repairs, $950; and net profit, $4,557. In 1914 royalty was paid amounting to $6,891.

Hunter district.—The output from 5 deep mines was 392,263 tons of ore, $13,539 in gold, 1,057,347 ounces of silver, 2,931,659 pounds of copper, 35,798,211 pounds of lead, and 3,184,490 pounds of zinc, in all valued at $2,546,703, or an average of $6.49 a ton. In 1913 the district produced 610,183 tons of ore, valued at $3,988,126. The decrease in 1914 was due to the temporary idleness of three mines in the district the latter part of the year. The greater part of the ore, or 366,928 tons, was concentrated into 40,150 tons of concentrates, and 25,235 tons of ore were shipped directly to smelters.

The 1,000-ton mill at the Morning mine was idle five months of the year, and the output in lead and zinc was about 70 per cent of that of 1913. According to the statement of the assessor, 202,400 tons of ore were extracted from the Morning mine, which had a gross value of $1,257,192. Cost of extraction was $560,882; freight and treatment, $549,695; betterment and repairs, $47,493; and net profit, $99,122. The Federal Mining & Smelting Co.,[1] operating this and other properties, gives the following data for all operations:

There were mined at all of the properties 421,631 tons (wet weight) of ore, of which 21,091 tons were first class. There were milled 389,450 tons (dry weight) of ore, an average of 32,454 tons per month.

There were produced during the year 57,058 tons lead concentrates and shipping ore, averaging 44.67 per cent lead and 16.01 ounces silver per ton; 4,200 tons zinc shipping ore and concentrates, averaging 44.61 per cent zinc. Of this amount 21,091 tons were first class, or shipping ore, which carried from 26.10 per cent to 59.2 per cent lead and averaged 34 per cent. The first class shipped from Wardner averaged 51.2 per cent and from Morning 29.6 per cent lead.

At Wardner the average silver content in concentrates increased from 20.19 ounces in 1913 to 22.4 ounces in 1914, and the average lead content from 55.93 per cent to 59.12 per cent.

At Morning the average silver content in concentrates was 13.42 in 1913 and 14.69 in 1914. The average lead content was 44.8 in 1913 and 44.67 in 1914. * * *

The total amount of development work for the year, consisting of drifting, raising, sinking, and crosscutting, was 7,256 feet, as against 16,224 feet during the previous fiscal period. The marked reduction is accounted for by the suspension of operations at Morning for practically five months of the year, the curtailment of operations at Wardner following the outbreak of the European war, and the relatively small amount of development now required by the Green Hill-Cleveland. The sharp fall in metal prices immediately following the war developments rendered it imperative to reduce expense as much as possible and development work was thereby curtailed in consequence. * * *

[1] Federal Min. & Smelt. Co. Ann. Rept. for year ending Dec. 31, 1914.

No new equipment was found necessary at the Wardner plant for the main mill, but a small flotation unit of 10 tons per day capacity, treating vanner tailings, was installed and has resulted in a satisfactory saving.

At the Morning mill a large flotation unit of a capacity of 480 tons per day was installed during the year. This new equipment includes one 50-foot Dorr thickener, in separate building, one No. 6 Root blower, one Bury 2-stage 19 by 12 by 12 [foot] air compressor, two 250 square foot Kelly filter presses, four electric motors of suitable capacity to drive unit, 18 pneumatic flotation cells. It is expected that this unit will add appreciably to mill efficiency and the plant profits. After extensive experiments with acid-flotation process, described in the report for 1913, it was found not to be best adapted to Morning ores and was therefore discontinued.

At the Green Hill-Cleveland mill a pneumatic flotation unit of 65 tons per day capacity was installed, equipped with one 40-foot Dorr thickener, one No. 4 Root blower, one Ingersoll-Rand 12 by 10 class E–R–1 air compressor, one 250 square foot Kelly filter press, four electric motors of suitable capacity to drive unit, and eight pneumatic flotation cells. These units which were put into service in August have resulted in a large increase in saving of available products and a corresponding increase in plant profits.

At the Frisco mill, in addition to the main mill completed during the year, a new flotation unit was added, equipped with one No. 3 Root blower, three Ding magnetic separators, and a complete flotation equipment with a capacity of 350 tons per day is partially installed. The completion of this installation early in 1915 should materially increase the output and value of mine products. In addition to the new material just mentioned a large amount of repairs and renewals was made, as shown in detail. New foundations were installed whereever required, and these plants are now more completely equipped and in better operating condition than at any time since erection.

The ore reserves January 1, 1915, were 62,200 tons at the Wardner mine, 673,150 tons at the Morning, 87,000 at Mace, 111,000 at Frisco, 55,100 at the Green Hill-Cleveland—a decided decrease at the last-named mine. * * *

The Helena-Frisco property, which was purchased under conditions shown at length in report for 1913, has received a large amount of rehabilitation, new construction, and development. After unwatering the mine it was found necessary entirely to retimber the shaft for a distance of nearly 1,600 feet, all the the level stations which would be needed in mining operations, and particularly the main hoist station. The mechanical equipment was also thoroughly overhauled and repaired.

It was found necessary to abandon the old mill and build practically a new one on the site of the old Black Bear mill, which is comprised in the Frisco holdings. A large part of the machinery installed being serviceable, was taken from the old Frisco plant. During the time consumed by this rehabilitation and construction rapid progress was made in the district in perfecting mill-concentration processes along the new flotation lines. After a trial run of the new mill it became evident that much better results could be secured by elaborating the process. These operations have consumed considerable time and entailed much expense.

It was found necessary to work out an entirely new process of concentrating this ore, involving much study on the part of the local staff and experts employed for that purpose. A process has now been developed, involving wet concentration, flotation, roasting, and magnetic separation, which it is believed will insure a relatively high efficiency. Installation of additional machinery found necessary will be undertaken early in the year and the plant started as soon thereafter as possible.

An underground reconnaissance has indicated that a considerable zinc-lead tonnage will be opened up by the necessary development work which is under way or will be initiated shortly. * * * The mill was operated in an experimental way from April 1 to May 10. On July 23 preparation was begun for construction of an addition to mill, covering the new flotation, roasting, and magnetic separation. On December 14 the mill started with one shift working underground. * * *

Options on the Star group, Flynn group, near the Morning, and the Phi Kappa group, in Custer County, were relinquished. * * *

The Morning property is in excellent shape, both underground and plant. The ore reserves as shown have increased substantially, though operations were conducted less than two-thirds of the fiscal time. Substantial additions have

been made to the milling plant, looking to increased capacity and efficiency, and extensive repairs, renewals, and betterments have been made to the older equipment.

At Mace early exhaustion of the ore bodies of the Green Hill-Cleveland Co. is indicated during the next year. This operation has been very profitable for the parties at interest, as shown by the financial statements accompanying fiscal reports.

In the old Federal ground, upon which operations were necessarily suspended after the Green Hill-Cleveland consolidation leased the Mace plant, there still remains a quantity of tonnage of rather low grade. With improved facilities in milling, which have been installed, this can now be operated at a profit and it is hoped to add to this tonnage by exploration and development in the ground which remains to be explored. * * *

At the Snow Storm mine the 250-ton concentration mill made copper concentrates until September 15, when work was confined to development. Several thousand tons of crude ore were also shipped, but the production of copper was only a little over half of the output in 1913. According to the statement of the assessor, 60,958 tons of ore were extracted from the Snow Storm mine, which had a gross value of $371,125. Cost of extraction was $202,956; freight and treatment, $48,784; betterment and repairs, $141,780; and net loss, $22,394. Dividends in previous years amounted to $1,192,103. The report[1] for the year ending June 30, 1914, includes the following information:

Shaft-sinking, crosscutting, driving, and raising above and below the 1,600-foot level cost $50,150. There was mined 99,501 tons of ore, of which 20,108 tons, assaying 4.16 per cent copper and 5.41 ounces silver per ton, was shipped, and 79,393 tons of 3.13 per cent copper and 4.52 ounces silver was concentrated. Revenue from ore and concentrate was $505,224 * * *. Operating expenses were $257,069 * * *. Development, installation of flotation plant, acquisition of the Ada claims, and lease on the Missoula property cost $152,904. Net earnings were $156,045, and $22,492 was paid in dividends. * * *

The Gold Hunter mine was operated the entire year, and the mill averaged 300 tons a day, though the capacity was later increased to 400 tons. The output of silver and lead increased slightly, and saving was increased toward the end of the year by adding flotation machines. According to the statement of the assessor, 10,543 tons of crude ore and concentrates were shipped from the Gold Hunter Mining & Smelting Co.'s mine, which had a gross value of $421,318. Cost of extraction was $293,304; and freight and treatment, $136,924; betterment and repairs, incorrectly printed, should have read $37,016; and the net loss was $45,926. On the 600-foot level, which is the deepest, the ore body was said to be 80 feet wide. The mine also has some gray copper rich in silver, which is being saved by flotation.[2]

A 500-ton mill was completed for the National Mining Co., and 12,000 tons of low-grade copper sulphide ore was treated by concentration and flotation. The plant was subsequently closed. The capital stock of the company was increased to $2,500,000 to purchase the Nellie claim, on which a large portion of the ore body is said to have been developed. The milling plant consisted of 1 Blake crusher, 1 Simons disk crusher, 6 Hardinge mills, 2 sets of rolls, 4 sets of Callow screens, 10 Deister and 10 Wilfley tables, Esperanza classifier, 8-cell Callow flotation plant, and Dorr thickener.

[1] Min. and Sci. Press, Apr. 8, 1914, p. 236.
[2] Ingalls, H. W., Min. and Eng. World, Mar. 6, 1915.

Lelande district.—Five deep mines produced 485,078 tons of ore, $18,563 in gold, 5,565,372 ounces of silver, 530,331 pounds of copper, 121,603,290 pounds of lead, and 5,379,306 pounds of zinc, valued in all at $8,183,621, or an average per ton of $16.87. Six deep mines produced 445,379 tons of ore, valued at $6,763,678, in 1913. The increase for 1914 was, therefore, $1,419,943, which is remarkable, considering the low price of lead. Of the ore produced, 445,132 tons were milled and made 78,786 tons of concentrates, and 39,946 tons were shipped directly to smelters.

The Hercules mine, at Burke, was the leading mine of the county in gross value of output and net profit, because it was the largest silver producer, although the Bunker Hill & Sullivan was a larger lead producer. During the year the mine was opened at greater depth by connection with the Hummingbird tunnel, which is 8,185 feet long and 800 feet lower than the former working tunnel. About 1,600 tons of high-grade crude ore was shipped per month, and the mill at Wallace was supplied with approximately 500 tons of ore per day. The mill consists of three buildings, of which the first houses the crushing, sorting, and grinding machinery; the second, the tables and vanners; and the third, a Callow pneumatic flotation plant. According to the statement of the assessor, 60,559 tons of crude ore and concentrates were shipped from the Hercules mine, which had a gross value of $4,147,610. Cost of extraction was $827,121; freight and treatment, $1,156,461; betterment and repairs, $295,266; and net profit, $1,868,762. Dividends paid in 1914 were not published. Those of past years are said to amount to $5,500,000.

The Hecla mine and mill were operated the entire year. The mill, which formerly treated 300 tons, was increased to a capacity of 375 tons and a small flotation plant was added. The company published the results[1] as follows: Ore mined, 123,857 tons; ore and concentrates shipped, 20,151 tons; lead content, 18,957,823 pounds; and silver content, 509,200 ounces. There were 170 men employed. According to the assessor, 123,857 tons of ore were extracted from the Hecla mine, which had a gross value of $925,869. Cost of extraction was $382,949; freight and treatment, $300,775; betterment and repairs, $46,008; and net profit, $196,137. Dividends paid in 1914 amounted to $220,000, and dividends to date were reported to be $3,190,000.

The Greenhill-Cleveland mine was active throughout the year and produced ore for the mill at Wallace, as well as first-class lead ore and lead-zinc ore. The mill averaged nearly 500 tons per day, making lead concentrates with good silver content and lead-zinc concentrates. Toward the end of 1914 the vanner tailings were treated in a 4-cell Callow pneumatic flotation plant. From a 70-ton feed, 15 tons of concentrates were made, containing about 37 per cent zinc and 21 per cent lead. This product went to the U. S. Zinc Co. at Blende, Colo. Experiments were also being carried on with the Wyman acid flotation process on the tailings from the Wilfley tables. A concentrate containing about 46 per cent zinc, 4½ per cent lead, and 17 ounces of silver was made. Aside from the flotation machines the mill had 1 crusher, 8 Wilfleys, twenty-eight 3-compartment Harz jigs, and 18 vanners. The mill feed contained about 9 per cent lead and 6.6 per

[1] Min. and Sci. Press, Apr. 24, 1915, p. 666.

cent zinc. According to the statement of the county assessor, 190,965 tons of ore were extracted from the Greenhill-Cleveland mine, which had a gross value of $2,324,961. Cost of extraction was $650,787; freight and treatment, $591,664; betterment and repairs, $35,754; and net profit, $1,046,757. This property is controlled by the Federal Mining & Smelting Co.

At the Frisco mine of the Federal Mining & Smelting Co. no shipments were made, but much work was done in testing the ore in the remodeled mill of 300 tons capacity. First tests were not successful on account of much iron in the ore, but, later, roasting and magnetic separation were used. This, with flotation, gives a lead product and a zinc product. Notes from the Federal report will be found under the Hunter district.

The Marsh mine at Burke was productive the first five months of the year, after which shipments ceased in order to complete underground work. The mill, which is a 175-ton plant, north of Wallace, is to be remodeled and flotation machines are to be added.

Placer Center district.—The district produced 138,600 tons of ore, $3,472 in gold, 556,851 ounces of silver, 62,994 pounds of copper, 17,588,182 pounds of lead, and 8,827,946 pounds of spelter, valued in all at $1,455,953, or $10.50 a ton. In 1913 the district produced 110,914 tons of ore, valued in all at $1,188,765, from which it will be seen that this district had an increased production notwithstanding lower prices of metal. Of the ore, 131,824 tons were milled, making 29,438 tons of lead and zinc concentrates, and 6,776 tons were shipped directly to smelters.

The Success Mining Co. operated the mine and 250-ton mill during the entire year, making about 1,200 tons of zinc concentrates and 100 tons of lead concentrates a month. Concentrates are passed through a 3-foot by 30-foot drying tube and to the magnetic separation plant. The freight rate is lower on account of the reduction in moisture and the grade of smelting material improved by the separation of iron. According to the statement of the assessor, 82,664 tons of ore were extracted from the Success mine which had a gross value of $232,521. Cost of extraction was $256,467 and net loss was $23,946; but the mill was improved. Past dividends declared amount to $930,000. The mine is developed by a 1,200-foot tunnel and a 400-foot incline shaft. On the 1,000-foot level 35 feet of 30 per cent zinc ore was reported to have been opened.

The Tamarack & Custer Consolidated Mining Co. was active all the year, and about 1,700 tons of lead ore and concentrates were shipped a month. The plant is 22 years old, was originally the Custer mill, and is now the Rex mill, being leased by the Tamarack Co. The mill recovery is reported to be about 83 per cent, without flotation. An aerial tramway 2 miles long connects the mine with the mill. In August 730 tons of lead ore were shipped and 5,598 tons of ore were milled and made 1,090 tons of concentrates and slimes. The concentrates after deduction for moisture assayed about 42 per cent lead. The directors were considering the erection of a new plant. According to the statement of the assessor, 20,685 tons of crude ore and concentrates were shipped from the Tamarack-Custer mine, which had a gross value of $957,359. Cost of extraction was $412,783; freight and treatment, $348,779; betterment and repairs, $13,542; and net profit, $182,256.

St. Joe district.—Three small placers and one deep mine produced ore and bullion valued at $1,462. From the Big Elk property a small shipment of oxidized copper ore was made, and part of the placer gold came from the Slim Show claim in a tributary of Niagara Creek.

Summit district.—This district around Murray was comparatively quiet during the year. From four deep mines and one placer a production was made of 1,464 tons of ore, $1,680 in gold, 1,750 ounces of silver, 24 pounds of copper, 251,071 pounds of lead, and 201,282 pounds of zinc, valued in all at $22,708. In 1913 the output was valued at $23,106 and in 1912 at $222,750. At the Monarch mine and the Paragon mine a few hundred tons of ore were concentrated and separated into a lead and zinc product.

Yreka district.—Eight deep mines produced 1,045,314 tons of ore, $24,760 in gold, 4,887,926 ounces of silver, 698,942 pounds of copper, 162,471,235 pounds of lead, valued in all at $9,157,120, or $8.76 a ton. This district has the largest output in total value in the State. It was followed closely, however, by Lelande district. Eight deep mines in 1913 produced 1,076,899 tons of ore, which had a total value of $8,348,492. Notwithstanding the curtailment that was necessary toward the end of the year the district had an increased production amounting in value to $808,628. Of the ore output 1,027,728 tons was milled and made 128,329 tons of concentrates. There were also 17,586 tons of first-class ore shipped directly to smelters.

The Bunker Hill & Sullivan Mining & Concentrating Co. remained the largest lead producer of the State, operated three mills, and averaged 1,200 tons of milling ore a day. Despite the low price of lead, the production of lead was 70,000,000 pounds, which was slightly less than the total of 1913. According to the statement of the assessor 440,819 tons of ore were extracted from the Bunker Hill & Sullivan mine, which had a gross value of $3,374,388. Cost of extraction was $1,060,150; freight and treatment, $1,352,362; betterment and repairs, $159,316; and net profit, $802,559. Dividends paid in 1914 amounted to $981,000, and to date $15,710,250. The following extracts are taken from the printed report of the company:[1]

Production has been well maintained and development of new ore has been highly satisfactory throughout the year. The prices received for our lead and silver were the lowest in the last 16 years of operations, and well below the average of the past 30 years; otherwise our net showing of profits would have equaled those won in any former year of our history. Prices are expected to improve only when normal conditions of trade are restored.

The Sierra Nevada Consolidated Mining Co. and the Caledonia Mining Co., the control of which is now owned by our company, as was explained in our last annual report, paid us substantial dividends during the year from their earnings and will continue to do so with certainty for years to come.

In the case brought by the Stewart Mining Co. against the Bunker Hill & Sullivan and Sierra Nevada companies, the United States Circuit Court of Appeals has confirmed the decision of the lower court given in our favor January 16, 1914. The only remaining litigation affecting our property is the recovery from the Stewart Co. of the value of the ore wrongfully removed by them from our ground.

The Kellogg shaft has been completed to the No. 14 level, 1,000 feet vertically below the Kellogg (mill adit) tunnel; station and ore pockets have been completed, electric pumping equipment [has been] installed, and crosscutting to

[1] Bunker Hill & Sullivan Mining & Concentrating Co. Ann. Rept. for year ending Dec. 31, 1914.

the ore shoots in two directions is now under way. All conditions are normal and indicate the opening of our ore bodies on this level in the early spring. Development on No. 13 level, touched upon in my last report, has gone on uninterruptedly throughout the year and continues to disclose good ore in quantity.

Our experimental and research work has resulted in further benefits to our milling and in the partial but highly promising development of certain electrochemical methods of recovering metallic lead, silver, and a little zinc from the mill wastes that may not be otherwise recovered. This promising work may in due time be so far expanded and perfected that substantial amounts of the metals will be won directly from your ores at Kellogg.

We have ore reserves blocked out to date: Stemwinder mine, 27,782 tons; Sullivan mine, 775,499 tons; Bunker Hill mine, 2,904,990 tons; making a total of 3,708,271 tons. * * *

Twenty-seven hundred and fifty-four (2,754) feet of drifts, crosscuts, and shafts were driven at a cost of $29,656.46. * * *

The concentrators were in operation for the full year, during which time 440,819 tons of ore were concentrated, making the average work of the concentrators 1,208 tons per day, or, say, 1,245 tons per 24 hours of actual operation, at a cost of $171,900.79. * * *

The company milled 440,819 tons of ore, making 56,163 tons of concentrates, assaying 62.91 per cent lead and 20.68 ounces of silver, or a total of 70,663,236 pounds of lead and 1,161,324 ounces of silver by wet assay, giving a total gross value for both metals of $3,362,499. The milling ore assayed 10.35 per cent lead and 3.796 ounces of silver per ton, and tailings assayed 2.675 per cent lead and 1.331 ounces of silver.

The total cost per ton of concentrates produced was $44.45. This included $15.54 for mining, $3.06 for milling, and $24.08 for freight and treatment. The total income per ton of concentrates was $64.63, leaving $20.18 profit.

From the beginning of operations in May, 1886, to the end of December, 1914, the property mined 6,462,867 tons of ore having a gross assay value of $60,231,542. The net smelter returns were $35,820,939; operating profit, $19,817,614; and dividends, $15,710,250.

The Stewart Mining Co. operated its mine and mill the entire year, shipping 500 tons of first-class ore and 2,500 tons of concentrates per month. These materials contain about 50 ounces of silver a ton, which makes the mine a larger producer of silver than the Bunker Hill & Sullivan. The output of the mine was increased at least 40 per cent over that of 1913. The ore is comparatively soft, containing no iron and very little zinc, which makes a high extraction possible in the mill. No zinc is saved. According to the statement of the assessor, 189,615 tons of ore were extracted from the Stewart mine, which had a gross value of $2,140,363. Cost of extraction was $612,794; freight and treatment, $669,819; betterment and repairs, $3,317; and net profit, $854,434. Dividends paid in 1914 amounted to $742,956, and to date $1,145,373. A local paper printed the following article in October, and it was partly checked at the Stewart mill at Wallace:

The capacity of the Stewart concentrator at Wallace, Idaho, is 500 tons. It is stated that in addition the Stewart is mining about 600 tons of high-grade ore monthly, assaying 50 per cent lead and 50 ounces silver per ton, which is shipped directly to the East Helena plant of the American Smelting & Refining Co.

About 6 tons of crude ore are concentrated into 1 ton of product, which is reported about 50 per cent lead and 50 ounces silver, and the tonnage of this product aggregates daily about 100. These concentrates also are shipped to the East Helena works. The mill feed contains about 7.9 per cent lead and 9.3 ounces silver; the jig concentrates, about 54 per cent lead and 41.8 ounces of silver; and the Wilfley concentrates, 58.6 per cent lead and 71.4 ounces silver. Stewart's tonnage is being had from the fourth, fifth, and sixth levels. Considerable development work, consisting principally of crosscutting, is in progress on the 700-foot level * * *.

A flotation plant has been installed at the Stewart mill, which is stated to be yielding very satisfactory results. An experimental flotation plant was started two months ago, and it began a recovery from the slimes which amounted to about $100 a day in value. The flotation method is said to be effecting a recovery of 60 per cent of the value of the slime product, which the Stewart used to throw into the creek as waste and unrecoverable. About 10 per cent of the slimes reach the flotation plant, assaying 2 per cent lead and 3 ounces silver, making a product with a content of 45 to 50 per cent lead and 115 ounces of silver. It is stated that about 45 tons of flotation concentrates are received monthly. * * *

The Stewart concentrator is equipped with 1 crusher, 4 sets of rolls, 2 Huntingtons, 12 Wilfley tables, 18 Frue vanners, about 36 Harz jigs, and 4 Deister slimers. The company's mine is located at Kellogg, Idaho, and there is a railroad haul of 12 miles to the mill, costing 15 cents a ton for the transportation. The mining costs of Stewart are comparatively low, approximately $1.80 per ton, as a result of a large portion of the ore being handled through a tunnel and the miners working under the best of conditions in respect to ventilation. The soft character of the country rock, which is Burke quartzite, is another factor in favor of economy, the rock breaking easily with a minimum amount of powder. The soft character of the country, however, has one disadvantage, it requires an extra amount of close timbering and is making that item costly to the Stewart. It is necessary to timber every foot of ground opened, the hanging wall being particularly heavy.

The following extract[1] is taken from the company's fiscal report:

Your company has also recently purchased 229,164 shares of the capital stock of the Coeur d'Alene Development Co., paying therefor 40,700 shares of the stock of the Stewart Mining Co. held in the treasury and without any cash disbursement. The 229,164 shares thus purchased, added to the 333,334 shares of Coeur d'Alene Development Co. stock already held by your company, has given the Stewart Mining Co. control of the Coeur d'Alene Development Co. by a stock ownership of 562,498 shares. The properties of the Coeur d'Alene Development Co. adjoin those of the Stewart Mining Co. and consist of 114 acres of mining land, deemed valuable with 10 patented claims. We are confidently advised by experienced engineers, whom we have consulted, that the valuable ore veins of the Stewart Mining Co. run into the adjoining properties of the Coeur d'Alene Development Co., and active work is now in progress from the 400-foot level. * * * Your directors are prosecuting this work with vigor, and the tunnel is being pushed with night and day shifts.

The Last Chance mine of the Federal Mining & Smelting Co. at Wardner was active the entire year and the mill was treating about 600 tons of ore a day. Crude ore and concentrates were shipped at an average of 1,650 tons a month. No zinc was saved, but flotation was installed to make a better saving in lead. The mine output was less than that of 1913. According to the statement of the assessor, 219,200 tons of ore were extracted from the Last Chance mine, which had a gross value of $942,108. Cost of extraction was $550,655; freight and treatment, $316,652; betterment and repairs, $1,859; and net profit, $72,943. Dividends and other data are given in the Federal Mining & Smelting Co.'s report under Morning mine in the Hunter district.

According to the statement of the assessor, 77,270 tons of ore were extracted from the Sierra-Nevada mine, which had a gross value of $566,825. Cost of extraction was $204,860; freight and treatment, $202,725; and net profit, $159,239. About 1,000 tons of concentrates were shipped a month and contained approximately 30 ounces of silver a ton and 50 per cent lead. The concentrates include the material

[1] Stewart Mining Co. Ann. Rept. for year ending June 30, 1915.

from the D. W. Peeples lease, reworking old fillings in a 200-ton concentration mill. The company operated a 500-ton plant, and the output of lead and silver was over four times that of 1913.

The Ontario mine also increased its output, shipping about 900 tons of crude ore and concentrates a month. A 200-ton mill was used. The product is of good grade, both in silver and lead. According to the statement of the assessor, 88,857 tons of ore were extracted from the Ontario mine, which had a gross value of $712,667. Cost of extraction was $237,514; freight and treatment, $228,992; betterment and repairs, $6,985; and net profit, $239,176.

In July regular shipments were resumed from the Caledonia mine, and thereafter about 1,000 tons of crude ore and concentrates were shipped a month. The ore contains more silver than in any other mine in the county and more copper than in any other lead mine of the region. A car shipped in October from the 300-foot level was said to contain 313 ounces of silver per ton, 7 per cent copper, and 17 per cent lead. According to the statement of the assessor, 22,336 tons of ore were extracted from the Caledonia mine, which had a gross value of $560,958. Cost of extraction was $64,988; freight and treatment, $173,114; and net profit, $322,857. Dividends paid in 1914 amounted to $130,250, or $182,350 to date.

Under date of August 29, 1914, the Mining and Engineering World says concerning the Caledonia mine:

> In settling the litigation with the Bunker Hill & Sullivan Mining Co. last fall, arrangements were made whereby the Caledonia ore was to be worked through the lower tunnel belonging to the Bunker Hill & Sullivan Co. and milled in a mill furnished by that company. In order to connect with the Caledonia mine it was necessary to drive a drift off to one side of the Bunker Hill tunnel and connect this drift with the Caledonia workings by means of 2 double-compartment raises, with stations at top and bottom. This work was begun last October, was completed in July, and is now in full operation. The mill furnished * * * by the Bunker Hill Co. was completely overhauled and equipped * * * with modern concentrating machinery. It has a daily capacity of 300 to 350 tons of mill feed, can be operated at a low cost, and will make as high extraction as any mill in the district. * * * During the month of June the mill was started and ran a few days; 360 tons of concentrates and crude ore were shipped. In July the production amounted to over 700 tons, about half of which was concentrates. This tonnage was produced with an average of 23 men employed in the mine. The crude ore gives net smelted returns of $50 to $60 per ton; the concentrates run from $60 to $140 per ton. We have a large body of good ore developed in the mine and will be able to show a low mining cost for a long time.

Two shipments of lead ore came from the Silver King mine of the Cœur d'Alene Development Co. One shipment of lead ore was also made from the Highland Surprise. The mill was idle, but will be active in 1915 making lead and zinc concentrates.

TWIN FALLS COUNTY.

Four operators of small placers produced $548 in gold and 3 ounces of silver, valued in all at $550.

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GOLD, SILVER, COPPER, AND LEAD IN WASHINGTON IN 1914.

(MINES REPORT.)

By C. N. Gerry.

PRODUCTION.

The value of the mine production of gold, silver, copper, and lead in Washington in 1914 was $809,767, a decrease of $243,368, or 23 per cent. There was decrease in the output of all metals as well as in the quantity of ore sold or treated, although the number of producing mines increased from 57 in 1913 to 67 in 1914.

The mine production of the State in 1913 and 1914 is shown in the following table:

Mine production of gold, silver, copper, and lead in Washington in 1913 and 1914.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	57	115,685	$696,275	331,239	954,081	202,487	$1,053,135
1914	67	95,947	557,173	264,861	778,728	65,507	809,767
Decrease (−) in 1914		−19,738	−139,102	−66,378	−175,353	−136,980	−243,368

[a] Includes a small placer production.

From the date of earliest production to and including the output of the year 1914, the State has marketed metals valued at $31,404,998, including gold, silver, copper, lead, and a small quantity of zinc. Of this total, the gold was valued at $25,987,294, the silver at $4,130,505, the copper at $762,462, and the lead at $523,563. The production by years was given in the report for 1913.[1] The following table gives the total output with the earlier years grouped by decades:

Production of gold, silver, copper, and lead in Washington, 1860–1914, by periods.

Period.	Gold.	Silver.	Copper.	Lead.	Total value.
	Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	
Prior to 1866	$9,000,000	120,500			$9,161,108
1866–1870	2,400,000	30,000			2,439,966
1871–1880	1,860,703	94,999			1,973,444
1881–1890	1,370,884	550,037			1,913,120
1891–1900	4,498,850	1,969,108	113,241	2,981,569	5,983,080
1901–1910	4,074,768	2,162,099	1,807,067	7,547,394	5,895,147
1911	847,677	243,781	318,207	848,584	1,056,017
1912	680,964	413,538	1,086,010	127,387	1,120,214
1913	696,275	331,239	954,081	202,487	1,053,135
1914	557,173	264,861	778,728	65,507	809,767
Total	25,987,294	6,180,162	5,057,334	11,772,928	31,404,998

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 790, 1914.

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PRODUCTION OF ORE IN 1914.

The quantity of ore sold or treated decreased from 115,685 tons in 1913 to 95,947 tons in 1914, or 17 per cent. This was caused by the temporary curtailment of the production in the Chewelah district of Stevens County. The total value of the ore per ton decreased from $9.07 in 1913 to $8.38 in 1914, and the value per ton in gold and silver decreased from $7.71 to $7.27. The output of dry or siliceous ore amounted to 77 per cent of the total ore and averaged $8.66 in gold and silver per ton. Copper ore constituted 22.7 per cent of the total and averaged $2.51 in gold and silver per ton. No zinc ore was sold, and the lead ore sold was less than 1 per cent of the total. The siliceous ore was composed of 73,618 tons of gold ore averaging per ton $7.44 in gold, 1.95 ounces of silver, 0.40 pound of copper, and 0.02 pound of lead; and 274 tons of silver ore averaging per ton $20.25 in gold, 89.71 ounces of silver, 9.88 pounds of copper, and 1.82 pounds of lead. The gold ore includes 16,395 tons of sulphide iron ore containing 463 ounces of gold, 1,279 ounces of silver, and 29,366 pounds of copper. The total siliceous ore, inclusive of iron ore, averaged 0.36 ounce of gold, 2.28 ounces of silver, 0.44 pound of copper, and 0.02 pound of lead a ton. The copper ore averaged 0.01 ounce of gold and 4.16 ounces of silver per ton, and 1.72 per cent of copper. Lead ore averaged 18.83 ounces of silver per ton and 10.51 per cent of lead. Part of the copper ore was concentrated, and a good part of the siliceous ore was milled.

Output of ore and mine production of metals in Washington in 1914, by kinds of ore.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Placers	17	.....	278.45	83	.....	.....
Dry or siliceous ore	34	73,892	26,453.86	168,499	32,431	1,816
Copper ore	10	21,752	220.93	90,574	746,297	.....
Lead ore	6	303	.....	5,705	.....	63,691
Total	.....	95,947	26,953.24	264,861	778,728	65,507

Subdivision of ore sold or treated from Washington in 1914, by kinds and by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan	264	.....	.....	264
Ferry	64,922	3,125	37	68,084
Kittitas	5	.....	.....	5
Okanogan	463	91	166	720
Skamania	.....	1	.....	1
Snohomish	494	1	.....	495
Stevens	5,902	18,534	100	24,536
Whatcom	1,842	.....	.....	1,842
Total	[a] 73,892	21,752	303	95,947
Average value per ton in gold and silver	$8.66	$2.51	$10.41	$7.27

[a] Includes 73,618 tons of gold ore and 274 tons of silver ore.

Nine milling plants were in operation in the State in 1914, against 14 in 1913. Of these 5 used amalgamation, 2 used cyanidation, and 2 concentration. With the exception of the mills at Republic and Chewelah, these plants were run intermittently.

Gold and silver mills treated 24,533 tons of ore in 1914, against 21,658 tons in 1913. Most of this ore was treated by cyanidation, as shown in the table following. The San Poil mill at Republic was active most of the year, but it was the only plant operated at Republic. About 43 pounds of mercury, 100 pounds of potassium cyanide, and 48,720 pounds of sodium cyanide were used at various mills. This gives an average of 0.02 pound of mercury per ton of ore amalgamated and 2.18 pounds of cyanide per ton of ore cyanided.

Ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Washington in 1914, by counties.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Chelan	264	45.19	22	25.00	4	$1,465
Ferry	22,187	.....	.....	7,577.18	41,245	179,443
Kittitas	5	9.72	5	.....	.....	204
Okanogan	235	59.26	50	.....	.....	1,253
Whatcom	1,842	715.03	178	.....	.....	14,879
Total	24,533	829.20	255	7,602.18	41,249	197,244

The output of concentrates increased from 1,130 tons in 1913 to 1,589 tons in 1914, and the quantity of ore concentrated from 10,793 tons to 13,581 tons. Chewelah district was the source of most of the concentrates. The mill of the United Copper Co. was idle part of the year, but its capacity was subsequently increased. Copper concentrates averaged 44 cents in gold and 27.31 ounces of silver, per ton, contained 7.26 per cent copper, and had an average value per ton of $34.86.

Mine production of gold, silver, copper, and lead from Washington concentrates in 1914.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.					Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Chelan	.....	1	6.00	2	104	.....	$139
Ferry	48	16	2.80	10	3,453	.....	523
Okanogan	303	102	57.50	1,863	252	19,206	3,002
Stevens	13,230	1,470	28.88	40,568	212,412	.....	51,281
Total	13,581	1,589	95.18	42,443	216,221	19,206	54,945

By kinds of concentrates.

Dry or siliceous	52	63.50	70	356	.....	1,399
Copper	1,486	31.68	40,578	215,865	.....	51,805
Lead	51	.....	1,795	.....	19,206	1,741

The output of crude ore shipped directly to smelters was 60.28 per cent of the total. Of this first-class shipping ore 85.1 per cent was siliceous, 14.6 per cent was copper ore, and less than 1 per cent was lead ore. The siliceous ore, which includes iron ore, averaged $7.54 in gold, 2.58 ounces of silver, 0.65 pound of copper, 0.04 pound of lead, and was valued at $9.06 a ton. First-class copper ore shipped averaged 46 cents in gold, 5.90 ounces of silver, and 62.59 pounds of copper, and was valued at $12.05 a ton. Lead ore shipped contained 26.07 ounces of silver a ton and 14.83 per cent of lead, and was valued at $25.98 a ton. Of the copper ore 8,427 tons were sulphide ore, containing 178.08 ounces of gold, 49,607 ounces of silver, and 518,004 pounds of copper. Of the lead ore shipped 113 tons were sulphide, containing 1,264 ounces of silver and 38,882 pounds of lead.

Mine production of gold, silver, copper, and lead from Washington crude ore shipped to smelters in 1914.

By counties.

County.	Crude ore to smelter.					Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Ferry	45,849	17,249.75	122,419	155,689	5,603	$445,207
Okanogan	182	15.01	6,126	15,829	3,185	5,927
Skamania	1	.....	5	142	.....	22
Snohomish	495	336.98	1,369	263	1,317	7,809
Stevens	11,306	546.49	50,912	390,584	36,196	92,811
Total	57,833	18,148.23	180,831	562,507	46,301	551,776

By kinds of ore.

Dry or siliceous	49,209	17,958.99	126,925	32,075	1,816	$445,772
Copper	8,474	189.24	49,996	530,432	.....	102,107
Lead	150	.....	3,910	.....	44,485	3,897

GOLD.

The mine production of gold was 26,953.24 fine ounces, valued at $557,173, against 33,682.30 ounces, valued at $696,275, in 1913, a decrease of $139,102. Of the total, 67.33 per cent, or 18,148.23 ounces, was derived from ores shipped directly to smelters; 31.28 per cent, or 8,431.38 ounces, was from ores treated by cyanidation or amalgamation; slightly more than 1 per cent, or 278.45 ounces, came from placers; and less than 1 per cent, or 95.18 ounces, came from concentrates. The table below shows that copper ore supplied less than 1 per cent of the gold, and that siliceous ores contained nearly all the remainder.

Source of mine production of gold in Washington, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Total.
Chelan	.....	76.19	.....	76.19
Clallam	5.32	.....	.....	5.32
Ferry	.....	24,730.16	99.57	24,829.73
Kittitas	202.51	9.72	.....	212.23
Okanogan	.....	117.77	14.00	131.77
Snohomish	12.14	336.98	.....	349.12
Stevens	.....	468.01	107.36	575.37
Whatcom	41.31	715.03	.....	756.34
Whitman	17.17	.....	.....	17.17
Total	278.45	[a] 26,453.86	220.93	26,953.24

[a] Includes 26,184.86 ounces from gold ore and 269 ounces from silver ore.

SILVER.

The mine production of silver decreased from 331,239 ounces, valued at $200,068, in 1913 to 264,861 ounces, valued at $146,468, in 1914. The decrease of 66,378 ounces was mainly in Stevens County. Crude ore shipped furnished 180,831 ounces, or 68.27 per cent of the total silver; bullion, 41,504 ounces, or 15.67 per cent; and concentrates, 42,443 ounces, or 16.02 per cent. Siliceous ore contained the greater part of the silver, or 63.62 per cent; copper ore, 34.20 per cent; and lead ore, 2.15 per cent.

Source of mine production of silver in Washington, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan	.....	28	.....	.....	28
Clallam	2	.....	.....	.....	2
Ferry	.....	160,159	869	2,646	163,674
Kittitas	66	5	.....	.....	71
Okanogan	.....	5,315	296	2,428	8,039
Skamania	.....	.....	5	.....	5
Snohomish	2	1,367	2	.....	1,371
Stevens	.....	1,447	89,402	631	91,480
Whatcom	10	178	.....	.....	188
Whitman	3	.....	.....	.....	3
Total	83	[a] 168,499	90,574	5,705	264,861

[a] Includes 143,919 ounces from gold ore and 24,580 ounces from silver ore.

COPPER.

The mine production of copper decreased from 954,081 pounds, valued at $147,883, in 1913 to 778,728 pounds, valued at $103,571. The decrease in Stevens County was partly offset by an increase in Ferry County. Crude ore produced 72.2 per cent of the copper, and concentrates 27.8 per cent. Only 4.16 per cent came from siliceous or iron ore, and the remainder came from copper ore.

Source of mine production of copper in Washington, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Total.
Chelan	104	.....	104
Ferry	6,781	152,361	159,142
Okanogan	1,639	14,442	16,081
Skamania	.....	142	142
Snohomish	.....	263	263
Stevens	23,907	579,089	602,996
Total	[a] 32,431	746,297	778,728

[a] Includes 29,722 pounds from gold ore and 2,709 from silver ore.

LEAD.

The mine production of lead in 1914 was only 65,507 pounds, valued at $2,555, against 202,487 pounds, valued at $8,909, in 1913. Crude ore produced 46,301 pounds and concentrates 19,206 pounds.

ZINC.

Since 1911 no zinc ore has been sold from the State, though there are zinc deposits in Pend Oreille County.

MINING INDUSTRY IN WASHINGTON IN 1914.

The depression in the metal market affected the production of silver and copper, especially in the Chewelah district of Stevens County. The largest mine in the district was idle part of the year until a contract was made with the Trail smelter. At Republic the production was less than was expected. There is need of larger milling capacity, cheaper power, and substantial capital in the camp, in which there are two good mills, but only one was operated, as the other was tied up by litigation. Shipments of crude ore also were affected by the market the latter part of the year.

Mine production of gold, silver, copper, and lead, in Washington in 1914, by counties.

County.	Ore.	Gold.		Silver.	
		Quantity.	Value.	Quantity.	Value.
	Short tons	*Fine ounces.*		*Fine ounces.*	
Chelan	264	76.19	$1,575	28	$15
Clallam	.....	5.32	110	2	1
Ferry	68,084	24,829.73	513,276	163,674	90,512
Kittitas	5	212.23	4,387	71	39
Okanogan	720	131.77	2,724	8,039	4,446
Skamania	1	.....	.....	5	3
Snohomish	495	349.12	7,217	1,371	758
Stevens	24,536	575.37	11,894	91,480	50,588
Whatcom	1,842	756.34	15,635	188	104
Whitman	.....	17.17	355	3	2
Total	95,947	26,953.24	557,173	264,861	146,468

Mine production of gold, silver, copper, and lead, in Washington in 1914, by counties—Continued.

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Chelan	104	$14			$1,604
Clallam					111
Ferry	159,142	21,166	5,603	$219	625,173
Kittitas					4,426
Okanogan	16,081	2,139	22,391	873	10,182
Skamania	142	19			22
Snohomish	263	35	1,317	51	8,061
Stevens	602,996	80,198	36,196	1,412	144,092
Whatcom					15,739
Whitman					357
Total	778,728	103,571	65,507	2,555	809,767

Ore sold or treated, number of deep mines producing, and average value of ores in Washington in 1913 and 1914, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1914	Increase (+) or decrease (−).	1913	1914	1913	1914	1913	1914
	Short tons.	*Short tons.*						
Chelan	264	− 6	2	3	$25.71	$6.08	$25.71	$6.02
Ferry	68,084	+ 286	12	17	11.09	9.18	10.96	8.87
King		− 155	1		41.31		41.31	
Kittitas	5	− 83	7	2	18.30	40.80	18.30	40.80
Okanogan	720	+ 191	6	12	24.30	14.14	23.85	9.96
Skamania	1	+ 1		1		22.00		3.00
Snohomish	495	+ 280	1	2	13.71	15.78	13.71	15.60
Stevens	24,536	−21,614	13	11	5.65	5.87	2.45	2.55
Whatcom	1,842	+ 1,362	3	2	11.35	8.08	11.35	8.08
Total	95,947	−19,738	45	50	9.07	8.38	7.71	7.27

[a] Value per ton, placer product excluded.

Seventeen placer mines produced in 1914, of which 14 were worked by hydraulic or sluicing methods and 3 were operated by drifting. Of the 50 active deep mines, 23 produced gold and silver; 2, silver only; 17, gold, silver, and copper; 7, silver and lead; and 1, gold, silver, and lead.

REVIEW BY COUNTIES.

CHELAN COUNTY.

Three deep mines produced 264 tons of ore, valued at $1,604, against 270 tons, valued at $8,704, in 1913.

Blewett district.—The Golden Eagle mine was operated for a few months during the latter part of 1914. The following notes[1] on the district are taken from a short article by the operator of the Golden Eagle mine:

Placer gold was discovered here in 1860, and the first quartz locations were made in 1874. Many ruins of ancient "arrastres" still testify to the activity

[1] Thurmund, F. L. R., Blewett, Washington: Alaska and Northwest Min. Jour., March, 1915, p. 51.

that followed the discovery of rich oxidized surface ores in Culver Gulch, where all the important mines are situated.

The formation in which the gold-bearing veins occur is serpentine altered from peridotite. * * *

The vein matter consists of quartz and calcite with a pure translucent green talc very common along the walls and intermixed with the quartz and calcite. The common sulphide is iron, with arsenopyrite next. Chalcopyrite is generally distributed, but in small quantities. The surface ores are highly oxidized and generally red and pulverulent. Gold occurs closely associated with all the minerals named, but the richest minerals are found in calcite and are associated with arsenopyrite and chalcopyrite. Ordinarily, it is difficult to see with the unaided eye, but is readily freed by mortaring, and the values can be roughly determined by panning. * * *

An examination of old assay records and other evidence indicates that the value of the ore mined would be about $25 per ton, but numerous ore shoots running into the hundreds are reported. * * *

The first gold mill was built here in the late seventies. It consisted of 6 stamps and a Frue vanner. * * * In 1891 a 10-stamp mill was erected, and the following year one of 20 stamps was built by the Blewett Gold Mining Co. The operation of this mill was very irregular until 1900, since when it has been idle. This mill handled about 20,000 tons of ore and produced in bullion about $200,000. * * *

Mismanagement, fraudulent stock selling, and litigation over ownership of claims and mill have paralyzed the camp since 1900. * * *

The Golden Eagle Mining Co. owns a group of claims and a small cyanide plant about a quarter of a mile west of Blewett and about 400 feet higher. This mill was built in 1907 and equipped with 6 stamps and a Wilfley table. On account of poor saving, the stamps and concentrator were taken out in 1913, and crushing rolls and leaching tanks installed. By crushing to 10 mesh and direct leaching for 72 hours an extraction of 80 to 85 per cent was obtained on oxidized surface ores.

The district has been described by the Washington Geological Survey.[1]

Entiat district.—Only a few tons of ore were milled at the Rex mine, which has been a larger producer in the past.

CLALLAM COUNTY.

A few ounces of placer gold were produced near Ozette.

FERRY COUNTY.

Ore sold or treated in Ferry County, Wash., in 1905–1914, and total content of gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	4	9,540	$86,053	34,945	.....	.....	$107,160
1906	10	6,364	70,742	26,463	52	.....	88,482
1907	5	2,168	4,032	14,321	131,731	.....	39,830
1908	7	722	17,333	7,906	1,144	.....	21,674
1909	9	11,453	210,437	53,694	606	.....	238,439
1910	19	37,874	714,808	185,357	61	128	814,913
1911	13	54,535	778,526	185,239	161,158	.....	896,848
1912	12	55,763	605,698	152,336	77,968	.....	712,250
1913	12	67,798	645,009	162,596	55,544	.....	751,826
1914	17	68,084	513,276	163,674	159,142	5,603	625,173
Increase (+) or decrease (−) in 1914	.....	+286	−131,733	+1,078	+103,598	+5,603	−126,653

[1] Weaver, C. E., Geology and ore deposits of Blewett mining district: Washington Geol. Survey Bull. 6, 101 pp., 1911.

There was a decrease in gold output, though other metals and the output of ore increased. Seventeen mines produced 68,084 tons of ore, of which 45,849 tons were shipped to smelters, 48 tons were concentrated, and 22,187 tons were cyanided. Of the total tonnage, 64,922 tons were siliceous or iron ore, 3,125 tons were copper ore, and 37 tons were lead ore. The county produced 71 per cent of the total tonnage, 92 per cent of the gold, and 62 per cent of the silver of the State in 1914. The value of the ore in gold and silver per ton decreased from $10.96 in 1913 to $8.87 in 1914. This region was described in a bulletin of the United States Geological Survey.[1]

Belcher district.—The Belcher mine produced a considerable tonnage of iron ore used as flux, and the Muldoon property east of Malo made a shipment of oxidized ore containing gold, silver, and copper.

Danville district.—The Lone Star & Washington property produced a copper sulphide ore, but the mine was closed in May, 1914.

Keller district.—The Iron Creek property was worked half the year, and a shipment of oxidized lead ore went to Trail, British Columbia.

Republic district.—From 1896 to the end of 1914 the Republic district has produced 342,092 tons of ore, $5,387,248 in gold and 1,551,130 ounces of silver, or a value for both metals of $6,234,850. The value of a small quantity of copper and lead has been excluded from this total value. Thirteen mines in 1914 produced 54,370 tons of ore, containing $508,262 in gold, 159,352 ounces of silver, and 1,322 pounds of copper, valued in all at $596,560, or an average value of $10.97 per ton. In 1913 the quantity of ore sold or treated was 54,375 tons, containing $636,925 in gold, 160,376 ounces of silver, and 369 pounds of copper, valued in all at $733,849, or an average value per ton of $13.50. All the ore was siliceous. In 1914 crude ore shipped amounted to 32,183 tons, containing 17,010 ounces of gold, 118,107 ounces of silver, and 1,322 pounds of copper. Ore cyanided amounted to 22,187 tons, from which 7,577.18 ounces of gold and 41,245 ounces of silver were recovered. The North Washington or White mill was idle, but the San Poil plant was operated nearly all the year on ore from the Knob Hill, San Poil, Surprise, Lone Pine, Pearl, Last Chance, and Ben Hur mines. Most of the ore, however, from the Ben Hur was shipped, and this mine was the largest producer of the district, having an output of about 2,000 tons a month of $10 ore. The Knob Hill mine was the next important producer, but its output was not equal to that of former years. It is stated that development work has not kept up with the shipments, and that the ore in the old stopes is about exhausted. The San Poil mine was an important producer. In September both mine and mill were taken over by the Western Union Mines Co., which also worked the Surprise, Lone Pine, Pearl, and Last Chance mines. The Surprise, Lone Pine, and Pearl had been shipping ore under a receivership most of the year, and it was thought that the production would greatly improve under Western Union management, but early in 1915 that company suspended operations. Other producing mines were the Rathfon or Republic, Quilp, Hope, Morning Glory, and Ida May. The Rathfon

[1] Bancroft, Howland, The ore deposits of northeastern Washington, with a report on the Republic mining district by Waldemar Lindgren and Howland Bancroft: U. S. Geol. Survey Bull. 550, 1914.

Reduction Co. owns the old Republic mine and the dump of tailings from former roasting and cyaniding. The plant which will be used when the camp gets cheap power consists of 1 tube mill, 5 feet by 22 feet; 5 Pachuca agitators, 25 feet high and 16 feet in diameter; 1 standard tank, 12 feet by 16 feet; 2 gold tanks, 12 feet by 16 feet; 2 sump tanks, 12 feet by 16 feet; 1 12-foot by 12-foot Oliver filter; 1 150-horsepower boiler; 1 12-foot by 12-foot air compressor; 1 70-horsepower slide-valve engine. The capacity is 70 tons for leaching.

Production from the Phil Sheridan mine is also included in this district. The camp is west of Republic, on the line of Okanogan County. A description of the Republic district and the flow sheet of the San Poil mill are given in the Mining and Scientific Press.[1] The principal features of the mill are a Williams chain hammer mill, a Traylor ball tube mill, a duplex Dorr classifier, an Akins classifier, Dorr thickeners, 9 Pachuca agitators, an Oliver continuous filter, and a Gates pebble tube mill. Some of the difficulties in milling are as follows:

> Four factors interfered with the success of the half-dozen earlier mills, besides the lack of a continuous ore supply of suitable grade; the high power cost, which is still a drawback; the hard quartz, some ribs being as high as 7 in the scale of hardness; necessity of pulverizing the ore till 90 per cent or more passed a 200-mesh screen to release the gold; and suitable grinders, agitators, and filters were not developed and consequently not used in the earlier mills.
>
> The power cost with steam, using coal at $6.60 per ton, is the largest item of cost, making nearly half of the total working cost in the San Poil mill.

A good idea of the value of the ore of the district is given by the following statement of the Republic Mines Corporation, which operated the Surprise, Lone Pine, and Pearl mines.

Production of Surprise, Lone Pine, and Pearl mines at Republic, Wash., from 1910 to 1913, with costs.

Year.	Tonnage.	Gold.	Silver.	Gross value.	Treatment.	Freight.	Net value.
	Short tons.	*Fine ounces.*	*Fine ounces.*				
1910—							
To smelters	19,233	24,924.81	125,265	$552,118	$88,273	$64,473	$399,372
1911—							
To smelters	18,749	17,389.20	77,096	367,563	86,241	55,361	225,961
1912—							
To smelters	18,943	15,254.77	74,153	334,353	110,719	27,916	195,718
To mill	7,679	3,671.97	21,928	68,652	30,713	3,072	34,867
1913—							
To smelters	12,387	5,235.43	32,136	120,669	43,667	11,550	65,452
To mill	796	292.88	2,035	6,399	4,776	190	1,433
Total	77,787	66,769.06	332,613	1,449,754	364,389	162,562	922,803

KITTITAS COUNTY.

Swauk district.—With the exception of a few tons treated by arrastres, the production came from placer operations. Nine placers and 2 deep mines produced $4,387 in gold and 71 ounces of silver.

[1] Morse, E. C., Mining and milling at Republic, Wash.: Min. and Sci. Press, Sept. 19, 1915, p. 435.

A list[1] of mines and operators was recently printed. It was reported that Swauk Creek would be sampled for possible dredge operations.

OKANOGAN COUNTY.

Twelve deep mines produced 720 tons of ore, $2,724 in gold, 8,039 ounces of silver, 16,081 pounds of copper, and 22,391 pounds of lead. The total value was $10,182, against $12,993 in 1913, as there was a decrease in the output of silver.

Conconully district.—Silver-lead ore was shipped from the Key mine and a good grade of silver ore from the Arlington mine.

Methow district.—Work was done on the Montana group on Goat Creek, which will be productive in 1915. The mine is equipped with a 14-ton amalgamation and concentration mill.

Meyers Creek or Chesaw district.—The region produced 220 tons of ore, $664 in gold, 227 ounces of silver, and 11,500 pounds of copper. The producers were the Molson, Reco, and Western Star, the first two producing gold and the last copper. These and other properties in the district have been described in the mining press.[2]

Nespelem district.—A shipment of silver ore was made from the Pittsburg property.

Palmer Mountain district.—Four deep mines produced 374 tons of ore, yielding $1,302 in gold, 2,669 ounces of silver, 3,194 pounds of copper, and 19,206 pounds of lead. The Caaba was operated under bond for a short time and lead concentrates were shipped. The Owasco was temporarily worked by the United Mines Co., managed by J. L. Harper, who was in charge of the Western Union Mines at Republic. Gold concentrates were shipped during the brief operations of the leasing company. The Caaba, at Nighthawk, and other mines near Loomis were briefly described in a recent article.[3]

SKAMANIA COUNTY.

Spirit Lake district.—The Cascadia Mining Co. did considerable development work on a copper property on which there is a shaft 200 feet deep and 4,000 feet of tunnels.

PIERCE COUNTY.

The only smelting in the State is done at Tacoma. The material treated is largely copper ore from Alaska, but custom ore from Republic and other districts in Washington is also treated.

SNOHOMISH COUNTY.

The value of the output from placers at Sultan and of gold ore from the Ben Lomond mine in the Monte Cristo district was $8,061.

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[1] Min. and Sci. Press, Mar. 16, 1914, p. 473.
[2] Ruggles, D. M., Chesaw, Washington: Alaska and Northwest Min. Jour., February, 1915.
[3] Ruggles, D. M., Loomis, Washington: Idem.

STEVENS COUNTY.

Ore sold or treated in Stevens County, Wash., in 1905–1914, and total content of gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	10	12,016	$165,863	26,195	15,449	604,843	$212,523
1906	10	12,270	77,837	6,372	72,313	926,100	148,849
1907	12	23,122	149,588	17,100	65,044	820,035	217,348
1908	15	31,863	183,893	53,296	248,432	1,146,929	293,104
1909	11	23,034	121,498	21,571	220,146	288,677	173,747
1910	12	18,473	30,182	13,281	85,063	1,321,871	106,319
1911	10	26,146	27,074	40,664	153,112	836,602	105,412
1912	9	37,080	23,823	233,535	1,007,076	127,387	339,347
1913	13	46,150	23,480	148,167	897,467	200,848	260,918
1914	11	24,536	11,894	91,480	602,996	36,196	144,092
Decrease (−) in 1914		−21,614	−11,586	−56,687	−294,471	−164,652	−116,826

There was decrease in the quantity of all metals produced in Stevens County in 1914, and the value of the output was 44.8 per cent less than that of 1913. Eleven mines produced 24,536 tons of ore, which had a total average value per ton of $5.87. Of the output of ore, 18,534 tons was copper ore, 5,902 tons siliceous or iron ore, and 100 tons lead ore. Of the total ore, 13,230 tons were concentrated and 11,306 tons were shipped directly to smelters. Of the copper ore, 5,304 tons was sulphide of shipping grade. Concentrates amounting to 1,470 tons had an average value per ton of $34.89.

Bossburg district.—Some sulphide lead ore was shipped from the Bonanza mine, though the property was idle most of the year. Some retimbering was done to prepare for shipments in 1915.

Chewelah district.—The output for 1914 was 18,527 tons of ore, which produced $2,219 in gold, 89,583 ounces of silver, 573,575 pounds of copper, and 1,109 pounds of lead, valued in all at $128,086, a decrease from $207,778 in 1913. From 1901 to the end of 1914 the district has produced 60,751 tons of ore, $57,147 in gold, 544,813 ounces of silver, 2,755,424 pounds of copper, 223,139 pounds of lead, valued in all at $804,909. The production of the Copper King mine was small. The mine is opened by a 1,900-foot tunnel and the ore is low-grade copper sulphide, with tetrahedrite and much siderite. A small furnace was built to use oil, but the results were not favorable. A shipment of silver ore was made from the Guaranty mine at Blue Creek. There are several properties that could be brought to the shipping stage, but the United Copper Mining Co.[1] remained the main producer, though the production was much less than that of 1913. Quotations from the company's annual report follow:

During the year a large amount of development work has been done, which has indefinitely prolonged the life of the mine by exposing a very large quantity of ore that will take many years to mine out.

On the 24th day of March, 1914, the 4,220-foot crosscut tunnel struck the vein at the 1,000-foot level and found it to be over 20 feet in width and containing several streaks of gray copper ore that proved high enough in values to ship crude, the rest being of a good milling grade. Upon drifting to the south the ore continued good for a distance of 300 feet and then pinched down very narrow, as it has done in the other leads in the upper works. Drifting has also

[1] United Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

been done to the north for a distance of 700 feet, in which the vein improved greatly, at times being 5 to 6 feet wide and extending out to 25 feet wide, all of which being of a grade that could be shipped crude at a fair profit with 16-cent copper, but at the present prices it has been found necessary to mill it after hand sorting. This drift is still going ahead on the vein, which shows up to be 15 feet wide in the face, all being a good grade of ore. It is very gratifying to notice that the tetrahedrite found in the upper levels is still showing in this lower level and has every appearance of continuing down to greater depth. The persistency and strength of the vein shown up by this drift is remarkable, its walls being well defined, and so far no slips or faults have been encountered for the entire distance opened up. There can be no doubt that it will continue to go down to a very great depth. The gangue of the ore on this level is similar to that in the upper works, being a siderite with small seams of quartz showing at times and chalcopyrite and tetrahedrite distributed from wall to wall. There is one exception: It is noticeable that small seams of pyrrhotite are coming in on the lowest level, none having been seen above. This has been tested and found to contain higher gold values than has been previously found in the mine. * * *

The mill has been doing very fair work, but the scarcity of water has been severely felt, there only being enough to supply little more than half the mill. Enough water is now being developed to supply all the requirements for running the whole mill and also increasing it, which will add materially to the output of the mine and enable a large cut to be made in the operating expenses.

The oil flotation process is being added to the mill, which, according to experiments already made, will make a very high extraction, greatly increasing the concentrate shipments. * * *

The oil flotation process mentioned in previous reports has been installed and is working very successfully. The object of this process is to effect a greater saving of the values in the slimes from the mill, and the work is being perfected to the point where practically the entire values of the mill feed will be saved.

The mill is being increased from 120 to 200 tons daily capacity. * * * At the present time some further prospecting is being done with diamond drill. * * *

The development work in the United Copper mine is practically done, and the operations for the coming year will be mainly that of taking out ore by means of stoping.

Prospects for other mines in the district are apparently good, as it is stated that the following properties would soon become shippers: Blue Star, Security Copper, June Echo, Copper Cliff, Chewelah Standard, Hecla, Washington group, Copper Queen, King, and Liberty. The district has been described by the United States Geological Survey.[1]

Kettle Falls district.—Small shipments were made from the Ben Venue, Sunday, and Rightside mines. The Rightside ore is copper sulphide ore; the others produce gold and silver.

Marcus district.—The Napoleon mine produced considerable iron sulphide ore containing gold, silver, and copper, but the property was closed in May.

Springdale district.—Work was resumed at the Togo mine, which produces copper ore.

WHATCOM COUNTY.

The main producer was the Boundary Red Mountain mine, in the Mount Baker district, at which the ore was amalgamated. Placer gold was produced in the Slate Creek district.

WHITMAN COUNTY.

A small placer production came from Snake River.

[1] Bancroft, Howland, Ore deposits of northeastern Washington: U. S. Geol. Survey Bull. 550, pp. 40–49, 1914.

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——— Notes on tungsten deposits near Deer Park, Wash.: Bull. 430, 1910.
——— The ore deposits of northeastern Washington, with a report on the Republic mining district by Waldemar Lindgren and Howland Bancroft: Bull. 550, 1914.
COLLIER, A. J., Gold-bearing river sands of northeastern Washington: Bull. 315, 1907.
——— Tin ore at Spokane, Wash.: Bull. 340, 1908.
HILL, J. M., Mining districts of western United States: Bull. 507, 1912.
RUSSELL, I. C., A preliminary paper on the geology of the Cascade Mountains in northern Washington: Twentieth Ann. Rept., pt. 2, p. 83, 1900.
SANFORD, SAMUEL, and STONE, R. W., Useful minerals of the United States: Bull. 585, 1914.
SMITH, G. O., Geol. Atlas, Ellensburg folio (No. 86), 1903.
——— and CALKINS, F. C., A geological reconnaissance across the Cascade Range near the forty-ninth parallel: Bull. 235, 1904.
——— Geology and water resources of a portion of Yakima County, Wash.: Water-Supply Paper 55.
——— Gold mining in central Washington: Bull. 213, 1903.
——— Geol. Atlas, Mount Stuart folio (No. 106), 1904.
——— and CALKINS, F. C., Geol. Atlas, Snoqualmie folio (No. 139), 1906.
SPURR, J. E., Ore deposits of Monte Cristo, Wash.: Twenty-second Ann. Rept., pt. 2, pp. 777–866, 1901.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA IN 1914.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

The mine production obtained from 4,522,022 tons of ore mined in Nevada in 1914, the placer output included, was valued at $29,300,842, a decrease in value of $7,796,868, as compared with 5,367,211 tons of ore, valued at $37,097,710, in 1913. There were 731 producers of ore and bullion in 1914, of which 111 were placers, as against 722 lode producers and 64 placers in 1913. The production of copper was nearly 28 per cent of the total in value, or $8,111,198, a decrease of $5,946,333 from the value in 1913. This reduced value of copper forms the largest part of the total decrease in 1914. The production of gold decreased from $11,795,130 in 1913 to $11,481,188 in 1914, or $313,942; silver, from $9,718,410 to $8,546,887, or $1,171,523; lead, from $719,137 to $499,577, or $219,560; and zinc from $807,502 to $661,992, or $145,510. The placer production of gold increased from $305,442 in 1913 to $377,262 in 1914.

Statistics showing the total mine production since 1904, with decrease for 1914, are given in the following table:

Ore sold or treated in Nevada, 1904–1914 number of producers, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.[a]
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	158	323,670	$5,060,494	4,268,123	29,317	4,229,727	.....	$7,658,216
1905	132	432,202	5,269,819	6,482,081	413,235	3,457,124	697,757	9,453,114
1906	154	496,307	10,470,704	6,770,611	1,625,985	3,823,617	2,886,328	15,714,841
1907	229	723,581	12,099,455	7,083,603	1,782,571	6,271,341	2,168,783	17,591,486
1908	421	1,425,532	11,362,941	9,508,464	15,598,788	7,245,619	1,115,851	18,818,228
1909	417	2,982,607	16,239,963	10,981,061	57,976,477	9,840,791	3,013,352	30,072,932
1910	608	3,655,775	18,878,864	12,479,871	64,359,398	4,871,130	2,707,071	34,152,148
1911	661	4,132,721	18,193,397	13,184,601	67,377,518	3,263,657	3,548,032	33,952,529
1912	704	4,763,965	13,456,180	14,369,063	86,477,494	19,500,100	13,322,988	38,358,732
1913	786	5,367,211	11,795,130	16,090,083	90,693,751	16,344,023	14,419,671	37,097,710
1914	731	4,522,022	11,481,188	15,455,491	60,986,450	12,809,655	12,980,232	29,300,842
Decrease in 1914.		845,189	313,942	634,592	29,707,301	3,534,368	1,439,439	7,796,868

[a] Includes placer production.

PRODUCTION OF ORE IN 1914.

Nevada's mines produced 4,522,022 tons of ore in 1914, a decrease of 845,189 tons compared with the production of 1913. The average total metallic value per ton was $6.40 in 1914, against $6.85 in 1913, and the gold and silver value per ton increased from $3.95 in 1913 to $4.34 in 1914. The largest decrease in production of ore was in White Pine, Lyon, Nye, Esmeralda, and Storey counties. The output of dry or siliceous ore decreased from 1,616,826 tons in 1913 to 1,594,486 tons in 1914. Under this classification is included 837,699 tons of low-grade siliceous gold ores, averaging per ton $8.25 in gold and 0.72 ounce of silver. Gold and silver mixed ores, dry or siliceous in character, aggregated 6,878 tons and averaged per ton $11.81 in gold, 23.36 ounces of silver, and a trace of copper and lead. The output of siliceous silver ores in 1914 amounted to 676,573 tons, mined by 100 producers and averaging per ton $4.47 in gold, 20.37 ounces of silver, and a trace of copper and lead, as against 697,775 tons mined in 1913 by 148 producers, whose ore averaged $4.29 in gold and 20.10 ounces of silver to the ton. A total of 73,336 tons of oxidized iron manganese ore was produced, largely from the Pioche district. This ore contained lead and small quantities of gold and silver and was particularly valuable at smelters as flux.

The production of copper ore by 66 operators amounted to 2,882,-121 tons and contained 49,476.59 ounces of gold, 181,733 ounces of silver, 60,398,084 pounds of copper, and 14,395 pounds of lead, the value per ton averaging $3.18. The output of lead ores decreased from 18,976 tons in 1913 to 16,088 tons in 1914. Lead ore of smelting grade amounted to 11,063 tons. In this smelting ore the oxidized ore, largely carbonates, predominated and increased in quantity from 6,452 tons in 1913 to 8,083 tons in 1914, which averaged $4.12 in gold, 16.95 ounces of silver, 20.8 pounds of copper, 263.4 pounds of lead, and $26.54 in total value per ton. The smelting sulphide ores of lead amounted to 2,980 tons and averaged $6.11 in gold, 29.20 ounces of silver, 12.2 pounds of copper, 317 pounds of lead, and $36.25 in total value per ton. Production of zinc ores of shipping grade decreased from 10,208 tons in 1913 to 9,440 tons in 1914. The oxidized or carbonate zinc ores were produced in largest quantity and amounted to 7,550 tons, from which was recovered an average of 626.72 pounds of zinc per ton. The zinc sulphide ores amounted to 1,890 tons and produced $3.19 in gold, 28.23 ounces of silver, 12.16 pounds of copper, 41.75 pounds of lead, and 577.99 pounds of zinc per ton. Production of copper-lead ores decreased from 6,197 tons in 1913 to 3,762 tons in 1914. Of this quantity, 3,475 tons were shipped without treatment. Of these direct shipments, 3,114 tons were oxidized or carbonate copper-lead ores, averaging 25 cents in gold, 20.71 ounces of silver, 79.06 pounds of copper, 272.6 pounds of lead, and $32.85 in total value per ton; and 361 tons were sulphide copper-lead ores, containing 16 cents in gold, 36.07 ounces of silver, 114.4 pounds of copper, 580.6 pounds of lead, and $57.95 in average value per ton. There were 16,075 tons of lead-zinc ore produced, the largest part of which was concentrated into a lead-zinc concentrate. Only 603 tons of lead-zinc ore was of shipping grade.

The output of milling ores was 4,229,770 tons, of which 1,461,577 tons were treated by amalgamation and cyanidation and the remainder, 2,768,193 tons, by concentration alone. The ores and tailings treated by cyanidation—1,211,169 tons of the former and 29,228 tons of the latter—yielded an average per ton of $6.18 in gold and 9.72 ounces of silver. The ores amalgamated, 250,408 tons, yielded bullion averaging per ton $5.69 in gold and 0.15 ounce of silver.

Output of ore and mine production of metals in Nevada in 1914, by kinds of ore.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine oz.*	*Fine oz.*	*Pounds.*	*Pounds.*	
Placers	111	.....	18,250.05	6,367	.....	.....	.....
Dry or siliceous ore	453	1,594,486	484,796.50	14,724,094	27,533	4,346,742	.....
Copper ore	66	2,882,121	49,476.59	181,733	60,398,084	14,395	.....
Lead ore	94	16,088	2,541.09	286,935	211,015	3,427,198	.....
Zinc ore	12	9,490	291.70	56,115	22,991	161,187	5,837,593
Copper-lead ore	8	3,762	46.54	85,109	325,404	1,136,797	.....
Lead-zinc ore	8	16,075	.....	115,138	1,423	3,723,336	7,142,639
Total	.....	4,522,022	555,402.47	15,455,491	60,986,450	12,809,655	12,980,232

Subdivision of ore sold or treated in Nevada in 1914, by counties, in short tons, and average value per ton in gold and silver.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	114,761	.....	10	.....	.....	.....	114,771
Clark	3,249	607	365	7,550	.....	16,039	27,810
Douglas	25	.....	.....	.....	.....	.....	25
Elko	8,353	531	130	.....	2,650	.....	11,664
Esmeralda	459,229	24,678	88	.....	.....	.....	483,995
Eureka	73,255	.....	3,006	50	15	.....	76,326
Humboldt	30,372	93	104	.....	.....	.....	30,569
Lander	6,101	.....	372	.....	.....	.....	6,473
Lincoln	78,645	2,101	8,173	1,890	487	36	91,332
Lyon	10,778	101,938	.....	.....	.....	.....	112,716
Mineral	73,965	1,936	256	.....	.....	.....	76,157
Nye	629,935	.....	35	.....	.....	.....	629,970
Ormsby	40	.....	.....	.....	.....	.....	40
Storey	103,406	.....	.....	.....	.....	.....	103,406
Washoe	2,259	306	2,730	.....	.....	.....	5,295
White Pine	113	2,749,931	819	.....	610	.....	2,751,473
Total	[a] 1,594,486	2,882,121	16,088	9,490	3,762	16,075	4,522,022
Average value per ton in gold and silver	$11.39	$0.39	$13.13	$3.90	$12.77	$3.96	$4.34

[a] Includes 837,699 tons of gold ore, 6,878 tons of gold and silver ore, 676,573 tons of silver ore, and 73,336 tons of iron ore.

GOLD.

The mine production of gold was valued at $11,481,188, a decrease of $313,942, in 1914, as compared with 1913. Esmeralda County is credited with the largest production of gold, amounting to $5,226,367, as against $5,721,077 in 1913. Nearly all of this output was from the Goldfield district, but the district produced $314,250 less than in 1913. The only counties having increase in gold were Eureka ($289,670), Mineral ($255,296), Humboldt ($244,941), Elko ($94,012), Lyon ($20,196), Lander ($12,701), and Douglas ($174). There was de-

crease in all other counties. Placer gold was produced in Nye, Lander, and Humboldt counties in greatest quantity, but also in 7 other counties, the value being $377,262, against $305,442 in 1913. The ore was milled in 1914 by amalgamation in 14 counties and by cyanidation in 13 counties. From these two methods of treatment $9,093,940 in gold was produced from 1,461,577 tons of ore and 29,168 tons of old tailings. The total average gold recovery from ore and tailings was $6.10 a ton. The gold extracted by amalgamation averaged $5.69 a ton of ore treated, as against $3.68 a ton in 1913; and by cyanidation it averaged $6.18 a ton of ore treated, as against $7.24 a ton in 1913. From copper, lead, zinc, lead-zinc, and iron sulphide concentrates 41,686.38 ounces of gold were produced, against 49,127.37 ounces in 1913. The largest quantity of gold (21,028.24 ounces) was contained in iron sulphide concentrates, against 26,747.48 ounces from this source in 1913; the copper concentrates contained 20,527.80 ounces, against 22,377.89 ounces in 1913; and the lead concentrates, 130.34 ounces, against 2 ounces in 1913.

Source of mine production of gold in Nevada in 1914, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	
Churchill	.....	15,433.60	.....	1.56	.....	.....	15,435.16
Clark	.....	4,463.62	4.01	1.11	.....	.....	4,468.74
Douglas	54.18	18.53	.....	.....	.....	.....	72.71
Elko	154.66	6,894.35	39.18	1.31	.....	30.19	7,119.69
Esmeralda	5.66	220,520.67	32,273.48	25.69	.....	.....	252,825.50
Eureka	410.51	13,779.57	.....	653.83	.....	.05	14,843.96
Humboldt	2,222.30	24,994.45	34.20	7.64	.....	.....	27,258.59
Lander	4,571.58	694.52	.....	277.53	.....	.....	5,543.63
Lincoln	.....	1,410.47	35.80	1,028.79	291.70	8.32	2,775.08
Lyon	.....	2,853.01	.39	.....	.....	.....	2,853.40
Mineral	259.58	17,987.76	19.83	125.10	.....	.....	18,392.27
Nye	10,345.04	152,986.33	.....	43.68	.....	.....	163,375.05
Ormsby	.....	18.91	.....	.....	.....	.....	18.91
Storey	.....	21,013.47	.....	.....	.....	.....	21,013.47
Washoe	103.81	1,618.24	23.80	7.84	.....	.....	1,753.69
White Pine	122.73	109.00	17,045.90	367.01	.....	7.98	17,652.62
Total	18,250.05	[a] 484,796.50	49,476.59	2,541.09	291.70	46.54	555,402.47

[a] Includes 334,137.48 ounces from gold ores, 3,929.80 ounces from gold and silver ores, 146,181.17 ounces from silver ores, and 548.05 ounces from iron ore.

SILVER.

The mine production of silver in Nevada in 1914 was 15,455,491 ounces, valued at $8,546,887, a decrease of 634,592 ounces in quantity and of $1,171,523 in value as compared with the output of 1913. Nye County was again in the lead, with 11,424,769 ounces, against 11,634,033 ounces in 1913; and Churchill County produced 1,545,926 ounces in 1914, against 1,383,257 ounces in 1913. The largest producer of silver was the Belmont mine, at Tonopah, in Nye County, followed by the Tonopah Mining Co. and the West End Consolidated. Milling plants using amalgamation and cyanidation in the extraction of the precious metals from ore produced 12,100,494 ounces of silver, of which 38,714 ounces were recovered by amalgamation and 12,061,780 ounces by cyanidation. Nye County is credited with

the largest production of silver, both by amalgamation—12,327 ounces—from ores from Manhattan and Round Mountain districts, and also by cyanidation—10,062,308 ounces—from ores treated principally in the Tonopah district. In Churchill County, where cyanidation was used, 1,421,086 ounces of silver were recovered. Concentrates from milling plants yielded 1,721,348 ounces of silver, against 2,135,714 ounces in 1913. The dry or siliceous ores milled produced 1,480,206 ounces from concentrates in 1914, against 1,865,416 ounces in 1913. Lead concentrates contained 139,562 ounces of silver, or an average per ton of 48.73 ounces, against 133,649 ounces, or an average per ton of 43.07 ounces, in 1913; lead-zinc concentrates contained 3.27 ounces per ton, against 4.62 ounces per ton in 1913.

Consequent upon the declaration of war in Europe a great depression in the silver market prevailed. With a few exceptions, the Tonopah mining companies stored their silver after July, 1914. The gold was sold, but as gold constitutes only 30 per cent of the total value, the proceeds from its sale by no means meet operating expenses. Aside from the silver situation, the European war has had a widespread effect in curtailing mining supplies, particularly supplies for cyanide mills. To date, however, this effect has not been felt in the Tonopah district and no cessation of operations has resulted from inability to procure supplies.

Source of mine production of silver in Nevada in 1914, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Churchill	.....	1,545,450	.....	476	.....	.....	.....	1,545,926
Clark	.....	4,654	1,131	3,549	2,761	.....	115,138	127,233
Douglas	7	7	.....	.....	.....	.....	.....	14
Elko	47	21,419	5,855	1,378	.....	60,414	.....	89,113
Esmeralda	2	69,640	87,074	5,205	.....	.....	.....	161,921
Eureka	25	124,563	.....	39,591	.....	23	.....	164,202
Humboldt	638	683,095	4,602	3,443	.....	.....	.....	691,778
Lander	626	162,990	.....	28,832	.....	.....	.....	192,448
Lincoln	.....	208,734	20,996	119,795	53,354	5,407	.....	408,286
Lyon	.....	18,417	97	.....	.....	.....	.....	18,514
Mineral	178	183,535	4,756	6,293	.....	.....	.....	194,762
Nye	4,786	11,419,166	.....	817	.....	.....	.....	11,424,769
Ormsby	.....	67	.....	.....	.....	.....	.....	67
Storey	.....	278,599	.....	.....	.....	.....	.....	278,599
Washoe	38	3,117	4,207	45,216	.....	.....	.....	52,578
White Pine	20	641	53,015	32,340	.....	19,265	.....	105,281
Total	6,367	[a] 14,724,094	181,733	286,935	56,115	85,109	115,138	15,455,491

[a] Includes 596,933 ounces from gold ores, 160,662 ounces from gold and silver ores, 13,784,744 ounces from silver ores, and 181,755 ounces from iron ore.

COPPER.

Nevada's mine production of copper in 1914 was 60,986,450 pounds, valued at $8,111,198, a decrease of 29,707,301 pounds in quantity and of $5,946,333 in value. Most of the copper was produced from the Nevada Consolidated mines at Ely, in White Pine County, and the Mason Valley mines, in the Yerington district of Lyon County. White Pine County mines produced 51,176,830 pounds in 1914, against

71,974,116 pounds in 1913; Lyon County mines, 7,274,329 pounds, against 15,106,475 pounds in 1913. Concentrates recovered at milling plants in Nevada contained 50,366,650 pounds of copper, against 70,049,254 pounds in 1913. Of the output in 1914, copper concentrates contained 50,350,664 pounds, against 70,041,011 pounds in 1913. Crude ore shipped to smelters contained 10,551,000 pounds of copper, against 20,610,520 pounds in 1913. The crude copper ores smelted contained 10,016,559 pounds, of which 8,038,035 pounds were produced from sulphide ores and 1,978,524 pounds from oxidized ores. Lead ores of smelting grade produced 205,210 pounds of copper, 36,467 pounds from sulphide ores and 168,743 pounds from oxidized ores. Copper-lead ores shipped contained 287,465 pounds of copper, of which the oxidized ores contained 246,185 pounds and the sulphide ores 41,280 pounds.

The Nevada Consolidated, at Ely, curtailed its output 50 per cent after September, production at the Mason Valley mines was suspended in October, and the furnaces at Thompson were closed in November. The most interesting developments of the year were the progress made on the leaching plant of the Nevada-Douglas property and the flotation tests made by the Nevada Consolidated, which may have an important bearing on the future production of Nevada copper mines, particularly those having ores of the lowest grade.

Source of mine production of copper in Nevada in 1914, by kinds of ore, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	3,892						3,892
Clark	6,110	178,639	1,982			1,423	188,154
Elko	23	86,596	377		186,337		273,333
Esmeralda	1,132	1,071,276					1,072,408
Eureka	890		2,568		3,342		6,800
Humboldt	1,218	30,861	873				32,952
Lander	4,741		3,031				7,772
Lincoln	779	388,860	188,341	22,991	59,618		660,589
Lyon	702	7,273,627					7,274,329
Mineral	3,655	240,284	597				244,536
Nye	3,114		148				3,262
Storey	1,094						1,094
Washoe	170	34,366	5,963				40,499
White Pine	13	51,093,575	7,135		76,107		51,176,830
Total	[a] 27,533	60,398,084	211,015	22,991	325,404	1,423	60,986,450

[a] Includes 12,851 pounds from gold ores, 2,157 pounds from gold and silver ores, and 12,525 pounds from silver ores.

LEAD.

The mine production of lead in Nevada in 1914 was 12,809,655 pounds, valued at $499,577, against 16,344,023 pounds, valued at $719,137, in 1913. Lincoln County mines continued to have the largest output, 5,985,679 pounds in 1914, followed by Clark County mines with 4,207,419 pounds and by White Pine County with 915,602 pounds. About 31 per cent of the output of lead was derived from concentrates and 68 per cent from crude ores shipped directly to smelters. Lead concentrates (carbonates and sulphides) from the milling plants of the State were shipped to the smelters and contained 2,798,176

pounds, against 3,412,030 pounds in 1913, and averaged 49.69 per cent of lead in 1914, against 54.98 per cent in 1913; lead-zinc concentrates contained 1,137,461 pounds, averaging 4.60 per cent of lead in 1914, against an average of 6.38 per cent in 1913. The total crude ore of shipping grade contained 8,794,246 pounds of lead against 9,757,899 pounds in 1913. Oxidized lead ore predominated and contained 2,129,828 pounds of lead, against 2,689,201 pounds in 1913. The sulphide lead ores contained 944,766 pounds of lead, against 1,033,336 pounds in 1913. Zinc ores shipped produced 161,187 pounds, of which 82,271 pounds were from oxidized and 78,916 pounds were from sulphide ores. Copper-lead ores of shipping grade produced 1,058,514 pounds, of which 848,952 pounds were from oxidized and carbonate ores and 209,562 pounds from the sulphides. The shipping lead-zinc ores produced 147,750 pounds of lead, of which the oxidized ores contained 130,553 pounds and the sulphides 17,197 pounds.

Source of mine production of lead in Nevada in 1914, by kinds of ore, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	1,304	.....	9,214	.....	.....	.....	10,518
Clark	22,244	.....	386,048	82,271	.....	3,716,856	4,207,419
Elko	73	11,359	69,016	.....	780,378	.....	860,826
Esmeralda	5,905	.....	34,830	.....	.....	.....	40,735
Eureka	14,620	.....	367,917	.....	9,153	.....	391,690
Humboldt	11,102	.....	21,393	.....	.....	.....	32,495
Lander	4,909	.....	61,223	.....	.....	.....	66,132
Lincoln	4,281,921	.....	1,550,179	78,916	68,183	6,480	5,985,679
Mineral	1,804	1,240	57,756	.....	.....	.....	60,800
Nye	2,860	.....	10,430	.....	.....	.....	13,290
Washoe	.....	.....	224,469	.....	.....	.....	224,469
White Pine	.....	1,796	634,723	.....	279,083	.....	915,602
Total	[a] 4,346,742	14,395	3,427,198	161,187	1,136,797	3,723,336	12,809,655

[a] Includes 33,493 pounds from gold ores, 21,841 pounds from gold and silver ores, 9,487 pounds from silver ores, and 4,281,921 pounds from iron ore.

ZINC.

The mine production of zinc from zinc and lead-zinc ores mined in Nevada in 1914 is estimated at 12,980,232 pounds, valued at $661,992, against 14,419,671 pounds, valued at $807,502, in 1913, a decrease in 1914 of 1,439,439 pounds in quantity and of $145,510 in value. Clark County is credited with the largest part of the output, or 11,862,149 pounds of zinc, from the Yellow Pine district. The remainder of the output was from the Pioche district in Lincoln County and from Eureka County. Lead-zinc concentrates amounted to 12,359 tons, and averaged 27.71 per cent of zinc. The shipments of zinc ore directly to the smelters amounted to 9,440 tons and consisted of 7,550 tons of carbonate and silicate ore and 1,890 tons of sulphide ore. The zinc ore shipped averaged 30.85 per cent of zinc and the lead-zinc ore 24.27 per cent.

Source of mine production of zinc in Nevada in 1914, by kinds of ore, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Clark	4,731,750	7,130,399	11,862,149
Eureka	13,439		13,439
Lincoln	1,092,404	12,240	1,104,644
Total	5,837,593	7,142,639	12,980,232

MINING INDUSTRY IN NEVADA IN 1914.

Nevada was not credited with the discovery of any new mining district of note and no new mine of exceptional importance was found in 1914, but there was much development in the mines of many camps and the construction of milling plants was general throughout the State. The discovery of platinum and palladium[1] on the west slope of Spring Mountain, 12 miles from Goodsprings, in the Yellowpine district, Clark County, awakened interest and caused renewed activity of many lead-zinc properties in the same locality. Silver and copper camps suffered after July from the depression in the metal market. At Tonopah, mining companies with few exceptions stored their silver, but the curtailment in the supply of cyanide of sodium and potassium, on which Tonopah depends for the extraction of silver from its ores, was not seriously felt, and no cessation of operations resulted from inability to secure supplies. The lack of a market for copper in the latter part of 1914 caused the Mason Valley mines to close in October and the smelter at Thompson a short time after. The Nevada Consolidated mines and smelter were affected to the extent of reducing production of copper to a basis approximating 50 per cent of the normal capacity. The Nevada Short Line Railway, better known as the Codd road, was completed from Oreana, a station on the Southern Pacific Railroad, to the new custom cyanidation mill situated at the lower town of Rochester, and the road was surveyed from the mill to the upper part of the district. The building for housing the machinery of the new mill was completed and was expected to be in operation in February, 1915. The principal event on the Comstock was the pumping operation in the Gold Hill mines.

The ores were milled at 82 plants, against 71 plants in 1913. Most of the plants were operated for short periods each year. Thirty-one plants used the amalgamation process, against 23 in 1913; 8, both amalgamation and concentration, against 13 in 1913; 3, amalgamation and cyanidation, against the same number in 1913. Seven plants used concentration alone, against 6 in 1913. Twenty-five straight cyanidation mills operated in 1914, against 20 in 1913; and 8 mills used cyanidation and concentration, against 6 in 1913.

During 1914 there were consumed at these mills 6,826 pounds of quicksilver and 3,217,886 pounds of potassium and sodium cyanide, a consumption of 0.063 pound of mercury per ounce of gold and silver bullion produced and of 0.03 pound of mercury per ton of ore

[1] Knopf, Adolph, A gold-platinum-palladium lode in southern Nevada: U. S. Geol. Survey Bull. 620, pp. 1–18, 1915.

treated. The consumption of cyanide was 0.258 pound per ounce of gold and silver bullion produced and 2.365 pounds per ton of ore and tailings treated.

Of the 1,461,577 tons of ore treated at gold and silver mills, 250,408 tons were treated by amalgamation and yielded 68,878.99 ounces of gold and 38,714 ounces of silver, an average recovery of $5.69 in gold and 0.15 ounce of silver per ton; the remaining 1,211,169 tons were treated by cyanidation and, with 29,168 tons of old tailings, yielded 371,040.38 ounces of gold and 12,061,780 ounces of silver, an average recovery per ton for ore and tailings of $6.18 in gold and 9.72 ounces of silver. The total value of the bullion recovered from ore and tailings was $15,785,513, as against $16,866,965 in 1913.

A table giving the quantity of ore treated and the content recovered at amalgamation and cyanidation mills follows:

Ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Nevada in 1914, by counties.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Churchill	[a] 114,682			14,430.20	1,421,086	$1,084,159
Clark	[b] 2,839	2,103.08	1,167			44,119
Douglas	25	18.53	7			387
Elko	7,950	[c] 3,607.43	[c] 2,926	[d] 2,781.05	[d] 10,689	139,591
Esmeralda	[e] 451,512	14,185.95	3,215	194,529.42	57,447	4,348,076
Eureka	73,003	3.75	1	13,485.00	107,248	338,146
Humboldt	[f] 15,522	18,596.03	14,034	130.02	10,072	400,433
Lander	1,830			[g] 485.53	[g] 12,039	16,694
Lincoln	3,753	2.28	1	747.22	237	15,625
Lyon	[h] 4,016	1,952.93	1,595	[i] 459.37	[i] 10,344	56,468
Mineral	[j] 63,065	1,335.91	513	[k] 14,293.87	[k] 129,097	394,771
Nye	[l] 619,748	22,265.28	12,327	[m] 115,709.73	[m] 10,062,308	8,423,469
Ormsby	15	1.88	2	[n] 17.03	[n] 65	428
Storey	[o] 101,322	3,125.28	2,232	[p] 13,971.47	[p] 240,245	487,512
Washoe	2,185	1,605.82	664	.47	903	34,071
White Pine	[q] 110	74.84	30			1,564
Total	1,461,577	68,878.99	38,714	371,040.38	12,061,780	15,785,513

[a] Also yielded 946 tons of concentrates.
[b] Also yielded 10 tons of concentrates.
[c] Includes bullion from 50 tons of old tailings.
[d] Includes bullion from 225 tons of old tailings.
[e] Also produced 25 tons of concentrates.
[f] Also produced 244 tons of concentrates.
[g] Includes bullion from 3,000 tons of old tailings.
[h] Also produced 13 tons of concentrates.
[i] Includes bullion from 6,220 tons of old tailings.
[j] Also produced 151 tons of concentrates.
[k] Includes bullion from 9,776 tons of old tailings.
[l] Also yielded 4,437 tons of concentrates.
[m] Includes bullion from 9,522 tons of old tailings.
[n] Includes bullion from 25 tons of old tailings.
[o] Also yielded 431 tons of concentrates.
[p] Includes bullion from 350 tons of old tailings.
[q] Also yielded 7 tons of concentrates.

Mills equipped for the concentration of low-grade ore treated 2,768,193 tons, or more than 61 per cent of the total ore sold or treated. The concentrates produced aggregated 467,686 tons, containing 41,686.38 ounces of gold, 1,721,348 ounces of silver, 50,366,650 pounds of copper, 3,937,126 pounds of lead, and 6,863,334 pounds of zinc (spelter), valued in all at $9,015,981, or an average value of $19.28 a ton. The two following tables give the quantity of ore concentrated, and of concentrates with their metallic content, by coun-

ties; also the production by kinds of concentrates and the averages for 1911–1914:

Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1914.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill		946	969.07	115,836	3,892			$84,607
Clark	15,472	14,631	10.09	114,402	1,423	3,575,586	6,849,895	552,455
Esmeralda	10,608	909	3,785.90	11,695	125,574	5,236		101,634
Eureka	2,405	292	44.58	22,000		165,000	13,439	20,208
Humboldt		244	2,470.71	15,626	27	3,700		59,862
Lyon		13	62.25	162				1,377
Mineral		161	290.37	90	3,625			6,534
Nye	4,437	14,038.62		1,324,320				1,022,553
Storey	1,623	559	3,165.28	24,310	952			79,002
Washoe	2,670	271	6.28	40,902	5,805	187,604		30,838
White Pine	2,735,415	445,223	16,843.23	52,005	50,225,352			7,056,911
Total	2,768,193	467,686	41,686.38	1,721,348	50,366,650	3,937,126	6,863,334	9,015,981

By kinds of concentrates.

Dry or siliceous		6,372	21,028.24	1,480,206	8,496	1,489		1,254,434
Copper		446,100	20,527.80	61,158	50,350,664			7,154,805
Lead		2,838	130.34	139,562	7,490	2,798,176		189,998
Zinc		17					13,439	685
Lead-zinc		12,359		40,422		1,137,461	6,849,895	416,059

Kinds of concentrates and average metallic content of each kind produced in Nevada in 1911–1914.

Kind and source of concentrates.	Quantity of concentrates.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
Gold and silver mills—							
1911	25,970	$47.72	92.00	0.02			$96.54
1912	5,106	154.17	386.86	.06	0.28		392.54
1913	4,449	104.61	406.00	.07	.09		350.14
1914	6,234	67.51	236.14	.07	.01		198.28
Concentration mills—							
1911	243	27.69	160.03	.07	.97		113.55
1912	500	122.94	66.89	3.82	.36		176.89
1913	578	151.41	102.23				213.17
1914	138	100.43	58.41	.10			133.00
Copper:							
Concentration mills—							
1911	242,099	1.76	.40	13.48			35.67
1912	329,585	1.40	.23	9.85			34.05
1913	480,116	.96	.15	7.29			23.67
1914	446,100	.95	.14	5.64			16.04
Lead:							
Concentration mills—							
1911	895	1.17	56.13	.03	29.07		57.15
1912	173	.32	67.37	.60	22.05		63.60
1913	3,103	.01	43.07	.03	54.98		74.50
1914	2,808	.37	48.73	.13	49.69		177.29
Gold and silver mills—							
1911	26	84.81	85.31	.53	9.02		139.46
1914	30	54.77	91.23	.44	12.41		116.07
Zinc:							
Concentration mills—							
1911	446		6.47		15.58	23.57	44.33
1914	17					39.53	40.29
Copper-lead:							
Gold and silver mills—							
1911	30	26.03	18.40	6.10	37.96		85.23
Lead-zinc:							
Concentration mills—							
1912	18,199		11.31		15.41	23.77	54.09
1913	13,642		4.62		6.38	29.45	41.39
1914	12,359		3.27		4.60	27.71	33.66

The two copper smelting plants were in operation in 1914, the one at Thompson until November and the Steptoe plant on half capacity the later part of the year. The Nevada Consolidated completed the acquisition of the property of the Steptoe Valley Smelting & Mining Co., the latter company having been dissolved on November 28, 1914. All operations of milling, mining, and smelting are now conducted by the Nevada Consolidated Co. Improvements at the mill consisted in adding Dorr thickeners and a new set of rolls. In the reverberatory smelting department there was a reduction in costs and in fuel ratio. The capacity per furnace was increased from 481 tons a day in 1913 to 598 tons in 1914. The following table gives the quantity of crude ore shipped to smelters, with metal yield, by counties in 1914, also the kind of crude ore, and the metals contained in each kind; and the table following next shows the average content during the period 1911–1914, inclusive:

Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1914.

By counties.

County.	Crude ore to smelters.						Total value.
	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill	89	35.89	9,004	.....	10,518	.....	$6,132
Clark	9,499	2,355.57	11,664	186,731	631,833	5,012,254	360,247
Elko	3,439	576.55	75,451	273,333	860,826	.....	123,567
Esmeralda	21,868	40,308.54	89,562	946,834	35,499	.....	1,010,094
Eureka	918	900.12	34,928	6,800	226,690	.....	47,667
Humboldt	14,844	3,805.33	646,806	2,064	28,795	.....	437,745
Lander	1,643	486.52	179,783	7,772	66,132	.....	113,091
Lincoln	86,141	1,924.92	394,387	660,589	5,985,679	1,104,644	635,524
Lyon	102,480	378.88	6,413	7,274,329	.....	.....	978,864
Mineral	3,216	2,212.54	64,884	240,911	60,800	.....	116,029
Nye	669	995.36	19,936	3,262	13,290	.....	32,553
Storey	111	751.44	11,812	142	.....	.....	22,084
Washoe	440	37.31	10,071	34,694	36,865	.....	12,392
White Pine	15,661	606.12	45,614	913,539	837,319	.....	191,911
Total	261,018	55,375.06	1,600,315	10,551,000	8,794,246	6,116,898	4,087,900

By kinds of ore.

Dry or siliceous	100,432	23,637.66	1,125,904	18,775	4,337,806	.....	$1,282,931
Copper	136,005	28,914.61	115,973	10,016,559	14,395	.....	1,994,615
Lead	11,063	2,490.25	224,033	205,210	3,074,594	.....	322,570
Zinc	9,440	291.69	56,115	22,991	161,187	5,824,154	343,438
Copper-lead	3,475	40.85	77,497	287,465	1,058,514	.....	123,216
Lead-zinc	603	.....	793	.....	147,750	292,744	21,130

Crude ore, by kinds, and average metallic content of each kind, produced in Nevada and shipped to smelters in 1911–1914.

Kind of crude ore.	Ore.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	67,584	$17.59	47.85	0.03	0.07	.....	$43.09
1912	60,830	11.24	17.94	.45	1.66	.....	25.26
1913	104,229	3.37	13.84	.....	2.10	.....	13.60
1914	100,432	4.87	11.21	.01	2.16	.....	12.77
Copper:							
1911	32,789	.76	.42	3.08	.....	.....	8.68
1912	290,082	.09	.34	3.54	.....	.....	12.00
1913	269,909	1.28	.62	3.72	.....	.....	13.19
1914	136,005	4.39	.85	3.68	.....	.....	14.67
Lead:							
1911	3,180	5.08	45.80	.13	24.07	.....	51.33
1912	17,650	3.14	19.77	.80	12.39	.....	29.08
1913	8,573	4.17	21.61	.58	21.71	.....	38.12
1914	11,063	4.65	20.25	.93	13.90	.....	29.16
Zinc:							
1911	3,013	.....	3.06	.01	3.00	32.36	41.24
1912	7,394	.01	.07	.....	.....	28.51	39.41
1913	10,208	.01	.41	.....	.46	31.09	35.50
1914	9,440	.64	5.94	.12	.85	30.85	36.38
Copper-lead:							
1911	216	4.55	45.49	5.47	16.99	.....	57.65
1912	168	.24	25.75	3.28	16.94	.....	42.16
1913	6,197	8.09	16.47	3.38	12.44	.....	39.46
1914	3,475	.24	22.30	4.14	15.23	.....	35.46
Lead-zinc:							
1911	2,337	.12	8.52	.....	14.84	29.69	51.85
1912	676	.....	4.26	.....	6.51	33.48	54.69
1913	62	.....	.....	.....	11.82	29.18	43.08
1914	603	.....	1.31	.....	12.25	24.27	35.04

A classification of kinds of crude ore smelted, separated into oxidized and sulphide ores, with average content, is shown in the two following tables:

Oxidized and sulphide crude ore, by kinds, including mixed dry ores and carbonate ores, produced in Nevada and shipped to smelters in 1914, and their metallic content.

Kind of ore.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	100,432	23,637.66	1,125,904	18,775	4,337,806	.....	$1,282,931
Copper:							
Oxidized	21,446	351.05	37,540	1,978,524	12,599	.....	291,652
Sulphide	114,559	28,563.56	78,433	8,038,035	1,796	.....	1,702,963
Lead:							
Oxidized	8,083	1,609.53	137,004	168,743	2,129,828	.....	214,541
Sulphide	2,980	880.72	87,029	36,467	944,766	.....	108,029
Zinc:							
Oxidized	7,550	.....	2,761	.....	82,271	4,731,750	246,055
Sulphide	1,890	291.69	53,354	22,991	78,916	1,092,404	97,383
Copper-lead:							
Oxidized	3,114	38.12	64,477	246,185	848,952	.....	102,295
Sulphide	361	2.73	13,020	41,280	209,562	.....	20,921
Lead-zinc:							
Oxidized	543	.....	793	.....	130,553	271,095	19,355
Sulphide	60	.....	.....	.....	17,197	21,649	1,775
Total	261,018	55,375.06	1,600,315	10,551,000	8,794,246	6,116,898	4,087,900

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Nevada and shipped to smelters in 1913 and 1914.

Kind of ore.	Ore.	Average metallic content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine oz. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1913	104,229	$3.37	13.84	.....	2.10	.....	$13.60
1914	100,432	4.87	11.21	0.01	2.16	.....	12.77
Copper:							
Oxidized—							
1913	67,304	.28	1.04	4.04	.....	.....	13.42
1914	21,446	.34	1.75	4.61	.03	.....	13.60
Sulphide—							
1913	202,605	1.61	.49	3.61	.....	.....	13.11
1914	114,559	5.15	.68	3.51	.....	.....	14.86
Lead:							
Oxidized—							
1913	6,452	3.71	20.82	.59	20.84	.....	36.47
1914	8,083	4.12	16.95	1.04	13.17	.....	26.54
Sulphide—							
1913	2,121	5.55	24.00	.53	24.36	.....	43.13
1914	2,980	6.11	29.20	.61	15.85	.....	36.25
Zinc:							
Oxidized—							
1913	10,136	.....	.33	.....	.46	31.06	35.40
1914	7,550	.....	.36	.....	.54	31.34	32.59
Sulphide—							
1913	72	1.44	11.36	.56	1.33	34.70	50.07
1914	1,890	3.19	28.23	.60	2.09	28.90	51.53
Copper-lead:							
Oxidized—							
1913	6,189	8.09	16.45	3.38	12.44	.....	39.47
1914	3,114	.25	20.71	3.95	13.63	.....	32.85
Sulphide—							
1913	8	.....	26.00	3.08	10.45	.....	34.37
1914	361	.16	36.07	5.72	29.03	.....	57.95
Lead-zinc:							
Oxidized—							
1913	.....	.....	.....	.....	.....	.....	.....
1914	543	.....	1.46	.....	12.02	24.96	35.64
Sulphide—							
1913	62	.....	.....	.....	11.82	29.18	43.08
1914	60	.....	.....	.....	14.33	18.04	29.58
Total, 1913	399,178	1.96	4.77	2.58	1.22	.80	14.82
1914	261,018	4.39	6.13	2.02	1.68	1.17	15.66

PRODUCTION BY COUNTIES.

GENERAL STATEMENT.

The following tables show the State output, by counties, in 1914, the production of each metal, and the total value; also the production of ore and the average value per ton, by counties, for 1913 and 1914, and the statistics of placer mines. The tables are followed by a review of the mining industry for each county and each producing mining district.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1914, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine oz.		*Fine oz.*			*Fine oz.*	
Churchill			15,435.16	$319,073	$319,073	1,545,926	$854,897
Clark			4,468.74	92,377	92,377	127,233	70,360
Douglas	54.18	$1,120	18.53	383	1,503	14	8
Elko	154.66	3,197	6,965.03	143,980	147,177	89,113	49,280
Esmeralda	5.66	117	252,819.84	5,226,250	5,226,367	161,921	89,542
Eureka	410.51	8,486	14,433.45	298,366	306,852	164,202	90,804
Humboldt	2,222.30	45,939	25,036.29	517,546	563,485	691,778	382,553
Lander	4,571.58	94,503	972.05	20,094	114,597	192,448	106,424
Lincoln			2,775.08	57,366	57,366	408,286	225,782
Lyon			2,853.40	58,985	58,985	18,514	10,238
Mineral	259.58	5,366	18,132.69	374,836	380,202	194,762	107,703
Nye	10,345.04	213,851	153,030.01	3,163,411	3,377,262	11,424,769	6,317,897
Ormsby			18.91	391	391	67	37
Storey			21,013.47	434,387	434,387	278,599	154,065
Washoe	103.81	2,146	1,649.88	34,106	36,252	52,578	29,076
White Pine	122.73	2,537	17,529.89	362,375	364,912	105,281	58,221
Total	18,250.05	377,262	537,152.42	11,103,926	11,481,188	15,455,491	8,546,887

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Churchill	3,892	$518	10,518	$410			$1,174,898
Clark	188,154	25,025	4,207,419	164,090	11,862,149	$604,970	956,822
Douglas							1,511
Elko	273,333	36,353	860,826	33,572			266,382
Esmeralda	1,072,408	142,630	40,735	1,589			5,460,128
Eureka	6,800	904	391,690	15,276	13,439	685	414,521
Humboldt	32,952	4,383	32,495	1,267			951,688
Lander	7,772	1,034	66,132	2,579			224,634
Lincoln	660,589	87,858	5,985,679	233,442	1,104,644	56,337	660,785
Lyon	7,274,329	967,486					1,036,709
Mineral	244,536	32,523	60,800	2,371			522,799
Nye	3,262	434	13,290	518			9,696,111
Ormsby							428
Storey	1,094	146					588,598
Washoe	40,499	5,386	224,469	8,754			79,468
White Pine	51,176,830	6,806,518	915,602	35,709			7,265,360
Total	60,986,450	8,111,198	12,809,655	499,577	12,980,232	661,992	29,300,842

Ore sold or treated, number of deep mines producing, and average value per ton of ores in Nevada in 1913 and 1914, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1914	Increase (+) or decrease (−).	1913	1914	1913	1914	1913	1914
	Short tons.	*Short tons.*						
Churchill	114,771	+ 30,870	12	19	$13.82	$10.24	$13.81	$10.23
Clark	27,810	− 8,545	47	27	38.48	34.41	7.27	5.85
Douglas	25	− 19	4	1	18.93	15.48	12.34	15.48
Elko	11,664	+ 6,496	43	38	24.40	22.56	15.31	16.57
Esmeralda	483,995	− 54,246	57	48	11.24	11.28	10.84	10.98
Eureka	76,326	+ 73,429	42	33	27.82	5.32	17.29	5.10
Humboldt	30,569	+ 4,984	114	78	30.03	29.62	29.82	29.43
Lander	6,473	− 21,236	35	15	6.21	20.05	5.35	19.49
Lincoln	91,332	− 5,223	22	20	8.23	7.23	3.63	3.10
Lyon	112,716	− 97,573	52	47	11.34	9.20	.20	.61
Mineral	76,157	+ 46,823	83	99	13.12	6.79	8.96	6.33
Nye	629,970	− 66,809	98	84	14.78	15.05	14.78	15.05
Ormsby	40	− 1,017	4	4	6.92	10.70	6.19	10.70
Storey	103,406	− 54,156	36	36	8.22	5.69	8.22	5.69
Washoe	5,295	− 1,107	47	45	19.86	14.60	15.23	11.93
White Pine	2,751,473	−697,860	26	26	3.40	2.64	.16	.15
Total	4,522,022	−845,189	722	620	6.85	10.51	3.95	4.34

[a] Value per ton, placer product excluded.

Number of producing placer mines and production in Nevada in 1913 and 1914, by counties.

County.	1913						1914					
	Hydraulic.	Drift.	Dredge.	Gold.	Silver.	Total value.	Hydraulic.	Drift.	Dredge.	Gold.	Silver.	Total value.
				Value.	*Fine oz.*					*Value.*	*Fine oz.*	
Douglas	1	....	....	$806	6	$810	1	....	....	$1,120	7	$1,124
Elko	1	....	....	1,488	28	1,505	7	....	....	3,197	47	3,223
Esmeralda	1	....	....	143	2	144	2	....	....	117	2	118
Eureka	4	....	....	1,511	5	1,514	12	....	....	8,486	25	8,500
Humboldt	6	....	1	12,898	238	13,042	15	....	1	45,939	638	46,292
Lander	11	1	....	27,162	188	27,275	12	2	....	94,503	626	94,849
Lyon	2	....	....	792	19	803	....	....	....	....	....	....
Mineral	1	....	....	170	10	176	7	....	....	5,366	178	5,464
Nye	15	20	....	260,472	5,867	264,016	27	12	....	213,851	4,786	216,498
Washoe	....	....	....	....	....	....	8	....	....	2,146	38	2,167
White Pine	....	....	....	....	....	....	5	....	....	2,537	20	2,548
Total	42	21	1	305,442	6,363	309,285	96	14	1	377,262	6,367	380,783

CHURCHILL COUNTY.

Nineteen mines in Churchill County are credited with a production in 1914 of 114,771 tons of ore, which was 30,870 tons more than was produced by 12 properties in 1913. The total average value per ton of this ore decreased from $13.82 in 1913 to $10.24 in 1914. Practically all of this value was for the gold and silver content. Nearly all of the ore was treated at milling plants, which recovered gold and silver bullion by cyanidation and which made also an important

output of gold and silver concentrates containing a little copper, which were shipped directly to the smelter. There were also 89 tons of crude ore containing lead shipped to the smelter. The total output of the district, when compared with the output of 1913, shows an increase in value of $15,635, due largely to the increase in production of silver.

Fairview district.—All the ore produced in 1914 was of milling grade, except 21 tons, which was shipped directly to the smelter. The output of the district, consisting of gold and silver bullion and concentrates containing a small quantity of copper, contained $117,903 in gold, 623,832 ounces of silver, 3,892 pounds of copper, and 9,214 pounds of lead, valued in all at $463,759, or an average value per ton of $7.18. The ore shipped directly to the smelter contained the lead and some gold and silver.

From the Nevada Hills mine[1] 64,348 tons of ore were mined and milled, and produced gold and silver bullion valued at $449,239, or an average recovery value per ton of $6.98 for the year. Total operating expense, including mining and milling, was $5.84 a ton.

Holy Cross district.—Gold and silver ore, said to have been mined in doing development work, was shipped from the Dream and the Silver Plume claims.

Jessup district.—Small shipments to smelters, consisting of gold and silver ore, were made from the Gold King and the Jessup Merger properties.

Wonder district.—Shipments were reported from four properties in the district during 1914. The largest production came from one property, the Nevada Wonder mine.[2]

The annual report of the company says:

> The mine was worked continuously throughout the year. The total production amounted to 48,570 tons of ore, having an average value of $15.52 per ton, an increase over the previous year of 9,452 tons of ore and an increase of $0.89 per ton in value. The average daily tonnage of ore produced during the year was 133.1 dry tons. * * *
>
> The deepest workings are now at a depth of 1,300 feet, and the horizontal extent of the workings is 3,400 feet from end to end. Exploration of the properties acquired from the Hidden Treasure Mining Corporation and the Wonder Extension Mining Co. was started, with excellent results. * * *
>
> The Nevada Wonder shaft was sunk, three compartments wide, from a depth of 1,033.5 feet to a depth of 1,342 feet. The Hidden Treasure shaft was sunk, two full compartments wide, from a depth of 182 feet to a depth of 308 feet, and enlarged to two full-sized compartments from the depth of 182 feet to the surface. The Wonder Extension shaft was sunk from a depth of 300 feet to a depth of 611.5 feet. These depths are measured from the collars of the respective shafts, but where levels are mentioned in this report they are numbered according to their depth below the collar of the main Nevada Wonder shaft. * * *
>
> A crosscut was run from the Wonder Extension shaft on the 800-foot level, and the south drift from this crosscut showed 35 feet of ore assaying around $20 for a width of 3 feet. The 800 north drift also showed some values, and is now following a strong vein of low-grade ore. The 1,000-foot drift from the Nevada Wonder shaft has now entered the ore shoot, and ore of milling grade is being mined.
>
> This ore shoot has now been opened on the 300, 500, 800, and 1,000 foot levels. * * *

[1] Nevada Hills Mining Co. [Fifth Ann. Rept.] for year ending Dec. 31, 1914.
[2] Nevada Wonder Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

A comparison of the costs of mining operations for the past two years is as follows:

	1912–13	1913–14
Total operating cost per ton of ore hoisted	$3.32	$4.65
Transportation of ore to mill per ton of ore hoisted	.05	.05
Total mining cost per ton of ore and waste hoisted	2.36	3.01
Total mining cost per ton of ore and waste broken	2.22	2.85
Shaft sinking—cost per ton of ore hoisted	.31	.55
Cost per foot of drifting, crosscutting, and raising	6.11	6.44
Cost per foot of shaft sinking:		
Nevada Wonder shaft	34.26	38.53
Hidden Treasure shaft		30.80
Wonder Extension shaft		31.57

These costs show an increase in direct mining costs of $0.72 and in indirect costs of $0.61 per ton of ore hoisted.

The increased operating costs for the year are accounted for by the greater amount of development work done and the longer distance through which the broken rock has to be trammed.

The combined costs of the Nevada Wonder Mining Co. and the Churchill Milling Co., and the profits per ton of ore mined, as compared with those for the previous year, are as follows:

	1912–13	1913–14
Mining cost per ton of ore	$3.37	$4.70
Shaft sinking per ton of ore	.31	.55
Enlarging shaft per ton of ore	.18	.04
Milling per ton of ore	3.25	3.37
Marketing products per ton of ore	.24	.28
Total cost per ton	7.35	8.94
Average value per ton of ore	14.63	15.52
Loss in tailing per ton of ore	.93	1.06
Recovery per ton	13.70	14.46
Less total cost per ton	7.35	8.94
Profit per ton of ore mined and milled	6.35	5.52

CLARK COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Clark County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	47	36,355	$144,090	198,922	351,855	6,265,783	14,369,709	$1,399,174
1914	27	27,810	92,377	127,233	188,154	4,207,419	11,862,149	956,822
Decrease in 1914		8,545	51,713	71,689	163,701	2,058,364	2,507,560	442,352

There were 27,810 tons of ore mined in 1914 by 27 producers, against an output of 36,355 tons made by 47 producers in 1913. The total average value per ton decreased from $38.48 in 1913 to $34.41 in 1914, and the gold and silver value in this ore from $7.27 to $5.85. The largest part of the output of ore, amounting to 15,472 tons, was sent to concentrating plants from which was produced 14,631 tons of zinc concentrates and lead concentrates containing principally silver

with a little copper and gold, valued in all at $552,455, or an average value per ton of $37.76. Also 9,499 tons of crude ore were shipped directly to the smelters and contained 2,355.57 ounces of gold, 11,664 ounces of silver, 186,731 pounds of copper, 631,833 pounds of lead, and 5,012,254 pounds of zinc, valued in all at $360,247, or an average value per ton of $37.92. At gold and silver mills 2,839 tons of ore were treated and produced $43,474 in gold and 1,167 ounces of silver. In the Yellow Pine district siliceous ore from one property produced gold, platinum, and palladium.

Eldorado Canyon district.—Testing of the ores continued at the property of the Rand Mining Co., which is equipped with a 10-stamp mill using amalgamation and concentration. The mill was operated only a few days; some gold and silver bullion and concentrates resulted from the tests.

Gold Butte district.—The Tramp claims were operated and a small quantity of copper ore, containing low values in silver, is reported to have been shipped. Brief notes by J. M. Hill,[1] of the United States Geological Survey, describe the geology as follows:

> Gold Butte, and a considerable area south of that peak, is composed of granite gneiss, schist, and granite of Archean age. North of the peak, and on its eastern flank, Paleozoic sediments, ranging from the Cambrian to the Pennsylvanian, have been faulted into their present position along a major series of northward trending breaks. In the limestone members of the sedimentary rocks there are some small bodies of copper oxide ores that are of the replacement type. Quartz veins of narrow width are found in the Archean granitic rocks. They are not strongly mineralized, and the sulphides are found close to the surface. A little free gold is found in the oxidized ores, but the pyrite, galena, and chalcopyrite of the sulphide zone do not appear to be particularly rich.

Searchlight district.—Five producers reported 3,057 tons of ore from the mines in the district in 1914. Of this ore, 2,685 tons were treated at gold and silver mills and 372 tons, containing gold, silver, lead, and a little copper, were shipped directly to the smelter. The total district output, consisting of gold and silver bullion and shipping ore, was valued at $85,830, or an average value per ton of $28.07. The principal part of the gold and silver produced was from the Quartette mine, which was operated almost all the year. The mill was operated about six months. A little gold and silver bullion was recovered from ores mined from the Blossom property and the Peerless group.

Yellow Pine district.—Nineteen producers reported the output of 24,537 tons of ore, containing $8,034 in gold, 122,703 ounces of silver, 156,389 pounds of copper, 4,185,208 pounds of lead, and 11,862,149 pounds of zinc (spelter), valued in all at $864,882, or an average value per ton of $35.25. The bulk of the ore (15,472 tons) was concentrated and was separated at lead and zinc plants, producing a lead and zinc concentrate. Shipments directly to the smelters aggregated 9,065 tons, containing 388.60 ounces of gold, 8,358 ounces of silver, 154,966 pounds of copper, 609,622 pounds of lead, and 5,012,254 pounds of zinc. In addition to the metals mentioned, some siliceous gold ore shipments contained 110.5 ounces of platinum and 168.16 ounces of palladium. The finding of these two metals in the Boss group was of special interest in 1914 and considerable prominence has been given the district in consequence. Some oxidized copper

[1] Hill, J. M., unpublished notes on some Nevada mining districts, 1914.

ore shipped also carried minor quantities of gold and platinum. A recent paper [1] published by the Survey describes the occurrence of these metals.

Much the larger part of the lead-zinc ore mined in the district was treated at the mill of the Yellow Pine Mining Co., which has a 100-ton concentration plant for separating oxidized lead and zinc minerals. It is equipped with classifiers, jigs, and tables. The lead concentrates are shipped to the lead smelters near Salt Lake City and the zinc concentrates to refineries in Oklahoma. The property was operated until November 10, 1914, and was closed temporarily because of an accident to the railroad equipment. The only important change in the mine was the sinking of a new shaft 800 feet deep during 1914. The principal properties producing were the Goodsprings Anchor, Bullion, Bill Nye, Goodsprings Dividend, Milford & Addison groups, Alice Copper and Zinc, Hoosier, Ingomar, Mobile, Monte Cristo, Ruth, New Year, Mountain Top, Potosi, Columbia, Xmas, and Singer.

Some details concerning the Yellow Pine mine and some of the other mining properties noted by the manager of the Yellow Pine Mining Co. follow:[2]

During the year the company milled approximately 13,000 tons of ore, of an average tenor of 31 per cent zinc, 14 per cent lead, and 11 ounces silver; from which was produced 2,150 tons of lead concentrate, averaging 55 per cent lead and 38 ounces silver; and 11,800 tons of zinc tailing, averaging 35 per cent, all of which was shipped. In addition to the mill products, a total of 1,100 tons of crude zinc ore was shipped, which averaged 43 per cent zinc. The above mill production was made with the mill operating but two shifts, or 16 hours daily. During the year a new 2-compartment working shaft was driven to a depth of 850 feet and a new surface plant installed, consisting of electric power plant, compressor plant, and electric hoist. Gas engines are used for generating electric power, which consume a cheap fuel known as special gas oil, which is obtained at a cost of 4½ cents per gallon, f. o. b. Jean. At the mine large bodies of lead-zinc carbonates have been developed on the lower levels, the ore reserves being larger than ever before in the history of the mine. * * * A wreck on the Yellow Pine Railroad, which badly damaged the Shay locomotive, necessitated a shutdown of the mill in November, but it is expected that full operations will be resumed shortly after the new year. At present only crude ore is being shipped.

Early in the year the Potosi property was purchased by the Empire Zinc Co. at a price said to be $175,000. The new company has installed many improvements, including an excellent motor-truck road from the mine to Arden, and motor trucks are used for hauling. A roasting plant has been installed to treat the zinc carbonate ores, which, it is expected, will result in a considerable saving in freight rates, etc. If this plant proves successful, others of similar character will undoubtedly be constructed in the district, which will result in distinct advantage to shippers of zinc carbonate ore. The Potosi property has maintained shipments of about 800 tons monthly.

Other properties which have maintained steady shipments of zinc and lead ores throughout the year are the Anchor, Bullion, Monte Cristo, Mountain Top, Alice, and Bill Nye. Dry concentrating plants of the Stebbins type have been erected at the Milford and Doran & Zenzen properties. An aerial tramway was recently erected at the Mobile, which property is now shipping about 300 tons per month, the ore being hauled to Jean by motor trucks. A large body of mixed lead-zinc ore has been developed at the Frederickson, and the owners expect to erect a mill in the near future. The St. Anthony produced during the year about 700 tons, assaying 20 per cent copper, but ceased shipments at the time of the break in the copper market.

[1] Knopf, Adolph, A gold-platinum-palladium lode in southern Nevada: U. S. Geol. Survey Bull. 620, pp. 1–18, 1915.

[2] Hale, F. A., jr., Yellow Pine Mining Co.: Salt Lake Mining Review, Jan. 15, 1915, p. 36.

DOUGLAS COUNTY.

Only one deep mine reported production in 1914, against four mines in 1913. The total average value per ton of ore produced decreased from $18.93 in 1913 to $15.48 in 1914. This value was principally that of gold and silver. The placer production amounted to $1,120 in gold and 7 ounces of silver.

Gardnerville district.—No production was recorded in 1914. This district covers the low foothills at the southeast end of Carson Valley and is largely drained by Buffalo Canyon. Daily stages operate between Gardnerville and Wellington and between Hudson and Wellington. The district is discussed in a recent report[1] published by the Survey.

Mount Siegel district.—A small quantity of gold taken out in 1913 from the Ancient gold placer, which is situated 20 miles due east from Minden on Buckeye Creek, was disposed of in 1914.

Red Canyon district.—In 1914 ore was treated at the Longfellow mill from the Pratt property. A small quantity of bullion and concentrate was produced. The latter was not shipped. The mines are in Red Canyon and on the crest of the mountains at the head of that canyon. Hudson is almost due east of the mouth of the canyon, but the mines on the summit are more easily reached from Minden and Gardnerville, in Carson Valley, west of the mountains. Minden, 1 mile northwest of Gardnerville, is the terminus of the south branch of the Virginia & Truckee Railway. The district is described more fully in the recent report by Hill.[2]

Wellington district.—This district lies in the southeastern part of the Pine Nut Mountain range, the mines being largely on the eastern and southern slopes of the mountains, adjacent to the town of Wellington. The district can be most easily reached from Hudson station, on the Nevada Copper Belt Railroad, which is in the east side of Smith Valley, 10½ miles northeast of Wellington. No production is recorded from mines in the district, but a brief description is given of the region by Hill.[3]

ELKO COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Elko County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	44	5,168	$53,165	45,482	200,342	361,880	$127,611
1914	45	11,664	147,177	89,113	273,333	860,826	266,382
Increase in 1914		6,496	94,012	43,631	72,991	498,946	138,771

[a] Includes placer production.

Thirty-eight producers reported the output of 11,664 tons of ore, or 6,496 tons more than was reported by 43 producers in 1913.

[1] Hill, J. M., Some mining districts in northern California and northwestern Nevada: U. S. Geol. Survey Bull. 594, pp. 51–64, 1915.
[2] Idem, p. 61.
[3] Idem, pp. 52–64.

The total average value per ton of the ore decreased from $24.40 in 1913 to $22.56 in 1914, and the gold and silver value in this ore increased from $15.31 to $16.57. The larger part of the ore, 7,950 tons, was of milling grade and yielded at gold and silver mills $132,062 in gold and 13,615 ounces of silver, valued in all at $139,591, or an average value per ton of $17.56. Included in this output was the gold and silver bullion recovered from 275 tons of old tailings. There were also produced 3,439 tons of ore of shipping grade, containing $11,918 in gold, 75,451 ounces of silver, 273,333 pounds of copper, and 860,826 pounds of lead, valued in all at $123,567, or an average value per ton of $35.93.

Centennial district.—A small quantity of gold and silver ore was shipped from the Richelieu property, which is opened by three adits aggregating 220 feet. Some bullion was recovered from mill cleanings of the Montana Lucky Girl property.

Contact (Salmon River) district.—A small quantity of copper ore, not exceeding one carload, containing gold and silver, was reported to have been shipped from the district. The properties being actively developed were the Delano, Blue Bird, Mammoth, and Lincoln groups.

Cornwall (Charleston) district.—Very little work was performed at the Marion property in 1914, and no large quantity of ore was shipped. Gold 0.908 fine from the Pennsylvania placer, operated a period of six weeks, was recovered from about 500 cubic yards of material.

Dolly Varden (Mispah) district.—No ore shipments were reported from the district in 1914, and very little development is known to have been accomplished. Hill,[1] who visited the district in 1914, describes it as follows:

> In the Dolly Varden district, northeast of Currie, between the Goshute and Antelope valleys, there are contact metamorphic deposits carrying copper and a few lead-silver bearing replacement deposits in early Carboniferous limestones intruded by a large stock of quartz monzonite. At the north end of the mountain, in what is known as the Mispah district, there are quartz veins in the intrusive rock carrying copper and gold.

Ferber district.—The Martha Washington and Salt Lake groups were operated early in 1914 and produced a little copper ore containing gold and silver. A description of the geology of the district is included under the chapter on the Toano Range.

Gold Circle district.—Nine producers reported the mining and milling of ore containing gold and silver. A small quantity of high-grade ore was shipped to smelters. Most of the ore was treated at the Rex Reduction Works and came from the Rex, Colorado, Elko Prince, Hardscrabble, Midas, and Judge properties. Most of the shipping ore was from the Eastern Star mine.

Jarbidge district.—Five producers reported 4,426 tons of ore, containing $75,992 in gold and 4,499 ounces of silver, valued in all at $78,480, or an average value per ton of $17.73. Most of the milling ore was reported to have been produced from the Alpha property, which is opened by an adit 800 feet long and is equipped with a 5-stamp mill, which was completed during 1913. The mine was worked continuously and the 5-stamp amalgamation mill was operated the

[1] Hill, J. M., unpublished notes on some Nevada mining districts.

greater part of the year. There was also a small quantity of ore shipped from the Bluster property directly to the smelters. It is reported that the Bluster mine is to be equipped with a mill, the duplicate of the Alpha plant. Only amalgamation will be attempted, and tailings are to be stored for future possible cyanidation. At the Success mine considerable development was accomplished to a depth of 427 feet.

Kinsley district.—The district is situated 38 miles southeast of Currie, near the county line. Copper-lead ore containing silver from the Morning Star property was reported by a lessee on the property. Hill[1] describes the geology as follows:

> Copper deposits occur in Cambrian limestones, which have been metamorphosed by the intrusion of a small stock of quartz monzonite. The development has not demonstrated any large bodies of ore; what ores are developed are limonitic copper carbonates, which are said to carry both gold and silver.

Medicine (Mud) Springs district and Delker Buttes.—In the vicinity of Mud Springs, at the north end of the Ruby Hills, lead-silver ores are found. The oxidized minerals occur in fissure replacement deposits in sediments of probable Permian age. At the north end of the eastern Delker Butte, on the east side of Ruby Valley, some veins and contact metamorphic deposits carrying copper carbonates occur in quartz monzonite, or at its contact with limestone and quartzite probably of Mississippian age.[1]

Railroad district.—Five producers reported the shipment of 2,942 tons of ore, containing $1,210 in gold, 61,296 ounces of silver, 234,018 pounds of copper, and 767,394 pounds of lead, valued in all at $96,159, or an average value per ton of $32.68. Most of the ore produced, containing copper, silver, and lead, came from the property of the Nevada Bunker Hills Co., which is opened by 5 adits from 100 to 1,500 feet long. The main working tunnel is 2,310 feet long. There were also important shipments from the Helen M. and Sweepstake properties. The Silvania and San Hone claims were also producers.

Ruby Mountain Range.—Shipments of zinc and lead carbonates have been made (in 1915) from the Polar Star, near Warm Creek, and zinc and lead sulphides from the Michigan claim, situated near South Creek, the latter belonging to the Arthur Zinc Co. These properties are situated 15 and 45 miles, respectively, from the loading station of Tobar, on the Western Pacific Railway. The Polar Star is operated by lessees, who are said to have shipped up to June 8, 1915, about 400 tons of ore, averaging 35 per cent of zinc. The property was a producer of lead ore in 1912. The Michigan was a producer of lead ore about six years ago; development work sufficient to cover assessment work has been performed since and in 1914. In March, 1915, shipments of zinc and lead sulphide ores were begun. The Ruby Range was recently described by Hill,[1] who says:

> The Ruby Range, composed essentially of biotite granite and quartz monzonite porphyry, both intrusive into early Paleozoic sediments, is on the whole poorly mineralized. A few widely scattered mining properties are located in areas of Paleozoic rocks on the eastern side of the mountains. In the Warm Creek region there are some lead and zinc prospects occurring in replacement deposits in limestones of probable Permian age. In Smith Creek district a small pro-

[1] Hill, J. M., unpublished notes.

duction of lead, zinc, and copper has been made from replacement and contact metamorphic deposits which occur in early Paleozoic sediments intruded by biotite granite. West of Hankins ranch some recently discovered bismuth-tungsten ores are closely associated with contact metamorphosed limestones, in the vicinity of quartz monzonite porphyry dikes.

Spruce Mountain district.—The old Spruce Mountain property, which was one of the earliest producers of lead-silver ores and was at one time equipped with a smelter, was reported in 1914 as being closed permanently, the property being abandoned and the company dissolved. Hill[1] states that the lead-silver and silver-copper deposits of the district occur as replacements and as veins in faulted Mississippian limestone adjacent to granite porphyry and diorite dikes. This, one of the older camps of Elko County, was first worked in 1869, and for a number of years Sprucemont was the largest town in the county. The mines have not been very productive in recent years.

Tecoma district.—Two small shipments of oxidized lead ore were made by the Montello Mining & Leasing Co. and the Little Butte Mining Co. Hill[1] describes it as follows:

> The Tecoma district, in the southeastern part of the Goose Creek Hills, is about 10 miles north of Tecoma, the most eastern town in Nevada on the Southern Pacific Railroad. The irregular replacement bodies of argentiferous cerusite occur along north-northwest fractures in Devonian and Mississippian limestones.

Toano Range.—This range, according to Hill,[1] extends southward from Toano Pass, on the Southern Pacific Railroad, to the Elko County line, a distance of 68 miles. It is composed for the most part of limestones and quartzites, which probably range from Cambrian to carboniferous. At White Horse Spring, near the south end of the range, the sediments have been intruded by a stock of porphyritic quartz monzonite in which there are small quartz veins carrying lead, silver, and copper. In the vicinity of Ferguson Springs there are small replacement deposits of limonite with some copper carbonates. A few miles south of the Southern Pacific Railroad, in the Luray district there are some prospects on replacement deposits in limestone. The oxidized ores consist largely of lead-bearing copper-pitch ore and malachite. In the Ferber district on the east side of the range, in the extreme southeast corner of Elko County, there are said to be large bodies of medium and low grade copper ore.

Tuscarora district.—Shipments of ore aggregating 380 tons, containing gold, silver, lead, and a little copper, were made from the region in 1914. Lessees shipped small quantities of gold and silver bullion. The total district output, including two small placer productions, was valued at $6,480. The Dexter mill and cyanide plant were destroyed by fire in December, and the loss was estimated at $150,000.

Van Duser district.—Prospecting work was carried on at the Gold Bug and Charlotte placer claims in the later part of 1914 and resulted in a small production of gold. Some gold was also produced from placer properties operated by Riordan & Alexander.

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[1] Hill, J. M., unpublished notes.

ESMERALDA COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Esmeralda County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	
1913	58	538,241	$5,721,077	188,361	1,288,819	288,674	$6,047,316
1914	50	483,995	5,226,367	161,921	1,072,408	40,735	5,460,128
Decrease in 1914		54,246	494,710	26,440	216,411	247,939	587,188

[a] Includes placer production.

Forty-eight producers reported in 1914 an output of ore amounting to 483,995 tons, 54,246 tons less than was reported by 57 producers in 1913. The total average value per ton increased from $11.24 in 1913 to $11.28 in 1914 and the average value per ton of gold and silver in this ore from $10.84 to $10.98. In no year have there been more than two or three very large producers of ore. Most of the ore (451,512 tons) was of milling grade and was treated principally by cyanidation, yielding $4,314,530 in gold and 60,662 ounces of silver, valued in all at $4,348,076, or an average value per ton of $9.63. This was a decrease from the output of 1913, when the total value of the milling ore reached $5,320,452, with an average recovery value per ton of $10.53. Also 10,680 tons of ore were concentrated and produced 909 tons of concentrate containing $78,262 in gold, 11,695 ounces of silver, 125,574 pounds of copper, and 5,236 pounds of lead, valued in all at $101,634, or an average value per ton of $111.80. The concentrates produced in 1913 were valued at $62,582 or an average value per ton of $88.39. In 1914 ores shipped directly to smelters aggregated 21,868 tons, containing $833,252 in gold, 89,562 ounces of silver, 946,834 pounds of copper, and 35,499 pounds of lead, valued in all at $1,010,094, or an average value per ton of $46.19. All the ore shipped in 1913 was valued at $664,044, or an average value per ton of $28.16. Some placer product, amounting to $117 in gold and 2 ounces of silver, was credited to the county.

Basalt district.—Ore containing gold and silver and some old tailings were treated in a 30-ton cyanide plant on the Thorndyke-Bley property. Ore was also treated in the 2-stamp mill on the I. X. L. claim.

Goldfield district.—From the year 1904 to the end of the year 1914, according to statistics collected by the Geological Survey, the Goldfield district has produced $71,311,552 in gold, 833,442 ounces of silver, 3,139,780 pounds of copper, and a small quantity of lead, probably from adjoining districts, valued in all at $72,255,497. Prior to the formation of the Goldfield Consolidated Co. $11,200,000 was taken from the constituent properties by lessees. Since their consolidation the property has produced approximately $50,000,000, from which dividends amounting to $27,398,215 have been paid. There were dividends paid by other companies which will be compiled in a later report. The following table gives the production of each year:

Ore sold or treated in Goldfield district, Esmeralda County, Nev., in 1904–1914, and total content of gold, silver, copper, and lead.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	
1904	8,000	$2,341,979	19,954	.....	.....	$2,353,353
1905	(a)	1,882,951	8,589	.....	.....	1,888,139
1906	59,628	7,026,154	15,648	.....	.....	7,036,638
1907	101,136	8,408,396	71,710	.....	.....	8,455,725
1908	88,152	4,880,251	30,823	1,606	.....	4,896,799
1909	297,199	9,383,261	33,164	52,015	.....	9,407,268
1910	339,219	11,137,150	117,598	107,282	.....	11,214,278
1911	390,431	10,287,075	126,406	72,998	.....	10,363,195
1912	362,777	6,239,747	125,736	579,539	3,581	6,412,859
1913	364,785	5,019,419	153,984	1,257,319	16,063	5,308,017
1914	367,166	4,705,169	129,830	1,069,021	4,018	b4,919,302
Increase (+) or decrease (−) in 1914	+2,381	−314,250	−24,154	−188,298	−12,045	−388,791

a Quantity not reported. b Includes a small placer output.

Twenty-one producers in 1914 reported the output of 367,166 tons of ore, which, together with a small placer output of bullion, contained $4,705,245 in gold, 129,830 ounces of silver, 1,069,021 pounds of copper, and 4,018 pounds of lead, valued in all at $4,919,302. The total average value per ton of the ore mined was $13.40, as against an output in 1913 valued at $5,308,017, with an average value per ton of $14.55. The bulk of the district output, or 334,934 tons, was treated at cyanidation plants and yielded 183,828.77 ounces of gold and 40,898 ounces of silver. At concentration plants 10,608 tons of ore produced 884 tons of concentrate containing 3,718.35 ounces of gold, 9,173 ounces of silver, and 125,312 pounds of copper. The ore shipped directly to smelters amounted to 21,617 tons, containing 40,051.74 ounces of gold, 79,759 ounces of silver, 943,709 pounds of copper, and 4,018 pounds of lead. Nearly all the copper came from the Goldfield Consolidated and Jumbo Extension properties and was contained principally in the ore of shipping grade, the remainder being recovered in concentrates partly at the Goldfield Consolidated plant from the treatment of the concentrates in a furnace prepared for the purpose of recovering gold and silver values. The entire concentrate production of the Jumbo Extension property is shipped to smelters.

During 1914 the Goldfield Consolidated mines[1] produced 338,192 tons of ore, of which 332,750 tons, of an average gross value per ton of $12.57, were milled and 5,442 tons, of an average gross value per ton of $29.01, were shipped. The gross value of the ore produced was $4,340,786.62.

[1] Goldfield Consolidated Mines Co. Eighth Ann. Rept., for year ending Dec. 31, 1914.

According to the annual report the following table outlines the operations of the Goldfield Consolidated Mines Co.:

Ore production, value, and average per ton of ore of the Goldfield Consolidated Mines Co.

	Production (short tons).	Total value [and deductions].	Average per ton.
Tons milled	332,750	$4,182,887.81	$12.57
Loss in tailing		384,935.56	1.16
Value recovered		3,797,952.25	11.41
Tons shipped	5,442	157,898.81	29.01
Smelter discount		27,227.34	5.00
Smelter settlements		130,671.47	24.01
Total production	338,192	3,928,623.72	11.62
Cost of ore purchased		2,275.10	.01
Value realized		3,926,348.62	11.61

Production by shafts.

Shaft.	Milling ore.			Shipping ore.		
	Short tons.	Average [value.]	[Total] value.	Short tons.	Average [value].	[Total] value.
Mohawk	180,511	$12.37	$2,233,100.29			
Combination	43,496	14.81	644,327.28			
Jumbo-Clermont	31,179	14.59	454,854.67	5,442	$29.01	$157,898.81
Laguna	38,201	13.37	510,840.87			
Jumbo No. 2	2,164	18.35	39,709.11			
Dumps	31,471	7.18	225,868.59			
Contractors	5,728	12.95	74,187.00			
Total	332,750	12.57	4,182,887.81	5,442	29.01	157,898.81

The equipment for rehandling mill tailing, which was referred to in the report for 1913, is now practically complete and will be available when needed. Its cost, which is to date $91,671.67, amounts to slightly less than 5 cents per ton for the tailing now available for re-treatment, and, in view of the low operating expense which will result from its use, it is believed that this initial expenditure will be fully justified. * * *

One dividend was paid within the year, at the rate of 30 cents per share, aggregating $1,067,744.40. * * *

The gross production of the company's ground to date is 2,111,054 tons of ore, of an average value of $30.15 and a total gross value of $63,658,088.83. Of this production, $11,200,000 was made by lessees in the early days and $2,700,000 was made by the constituent companies prior to their acquisition by this company. The gross production by the company itself has been approximately $50,000,000. To date the company has paid dividends amounting to $27,398,215, or $7.70 per share.

The Florence-Goldfield mine[1] in 1914 yielded 8,028.59 dry tons of ore, which had a gross value of $211,859.44, or an average value per ton of $26.39.

[1] Florence Goldfield Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

The report says:

Developments in the Goldfield district during the past six months at depth on the shale-latite contact have proven the existence of large and very profitable bodies of ore lying on or in close proximity to the contact. In a property sidelining your company's property commercial ore of good width and value exists at a depth of 1,750 feet, practically on the contact, at a distance of approximately 700 feet from the Florence property's side line. The contact at this depth has an almost true east and west strike, which would take it into the Florence property at about right angles to the property's side line. The apparent dip of the contact is about 30° to the south.

The main Florence vein, as exposed by the lateral work on the 1,000-foot level, the deepest point at which the vein has been cut, shows an approximate width of 75 feet. The vein at this depth is strong and well defined and carries values of from 80 cents to $4.80 through the entire length and width exposed.

The vein at this depth is in the latite, and the bottom of the three-compartment main shaft at a depth of 1,270 feet is also in the same formation. The shaft would in all probability have to be sunk to a depth of 2,000 feet in order to develop along the shale-latite contact, but the contact might be exposed before a depth of 2,000 feet was reached.

The main Florence vein has produced from practically one continuous ore body nearly 1,000 feet in length, except as displaced by the Engineers fault. In the south portion of the vein ore has been stoped to within 70 feet of the 650-foot level. Ore stoped from this southern section of the vein carries both silver and copper in commercial quantities, besides gold, a characteristic of all ore found at depth on the shale-latite contact in this district.

Productive veins in neighboring properties have had nonproductive sections on the downward extension to the shale contact, and have made profitable bodies of ore on the contact.

The Jumbo Extension mine[1] during the fiscal year of the company produced 18,813 wet tons of ore, of which 5,939 tons were milled at the Goldfield Consolidated plant and 11,477 tons were shipped to the smelter. Altogether the milling and smelting ore netted the company $339,373.22.

Other producers in the region were the Goldfield Belmont, Goldfield Combination Fraction, Diamondfield Daisy, Great Bend, and Sandstorm Kendall.

Gold Mountain district.—The output of the district consisted of 221 tons of ore, produced from four properties, and contained $1,712 in gold, 2,964 ounces of silver, and 2,338 pounds of copper, valued in all at $3,442, or an average value per ton of $15.57. The principal production was from the Hasbrouck claim, with smaller productions from the Mammoth and Gold Zone properties.

Hornsilver district.—Altogether 157 tons of ore were mined, containing $3,758 in gold, 4,553 ounces of silver, and a little lead, valued in all at $6,302, or an average value per ton of $40.14. The principal gold and silver producer was the Gold Mountain mine, which is opened by two inclined shafts 300 feet deep. It is reported that at this depth the sulphide zone has been encountered in one shaft. Some ore was also shipped from the Galena Gold and the Little Carrie properties.

Lida district.—Two producers reported the shipment of 3 tons of ore, carrying principally gold but also a little copper, which was shipped to the smelter.

Lone Mountain district.—Shipping ore produced from six properties aggregated 74 tons, containing $149 in gold, 5,281 ounces of silver, 30,812 pounds of lead, and a small quantity of copper, valued

[1] Jumbo Extension Mining Co. Ann. Rept. for year ending June 30, 1915.

in all at $4,299, or an average value per ton of $58.09. The principal shipments, containing lead, were made from the Quincy property, which is opened by a vertical shaft 225 feet deep.

Silver Peak district.—The mine and plant of the Pittsburg-Silver Peak Gold Mining Co. were operated the entire year and treated the usual quantity of gold and silver ore in its 120-stamp mill equipped with a 500-ton cyanide plant. The ore mined and treated is a hard quartz averaging $5 in gold per ton. A large proportion of the gold is finely disseminated and in a free state, although it is also contained in scattered pyrite, and, rarely, in galena which occurs sparsely through the quartz. Silver is present in part of the ore in a ratio of about 1 to 100 as compared with the gold. The quartz occurs in the form of overlapping lenses cutting thin-bedded metamorphosed limestones and frequently associated with similar lenses of alaskite. The general dip of the lenses and the lens zones is 30°. The mill and process of treatment, including costs, are described and fully reviewed in a recent publication.[1]

EUREKA COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Eureka County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	46	2,897	$17,182	56,996	55,385	498,104	.....	$82,110
1914	45	76,326	306,852	164,202	6,800	391,690	13,439	414,521
Increase (+) or decrease (−) in 1914		+73,429	+289,670	+107,206	−48,585	−106,414	+13,439	+332,411

[a] Includes placer production.

The output of ore in the county in 1914 was 76,326 tons, reported by 33 producers, or 73,429 tons more than was reported by 42 producers in 1913. The total average value per ton decreased from $27.82 in 1913 to $5.32 in 1914, and the gold and silver value per ton of this ore from $17.29 to $5.10. Most of the ore mined (73,003 tons) was treated at gold and silver mills and yielded $278,837 in gold and 107,249 ounces of silver, valued in all at $338,146, or an average recovery value per ton of $4.63. This was a great increase over the production of 1913, when only 1,060 tons were treated at gold and silver mills. At milling plants equipped with concentrating apparatus, 2,405 tons were treated and produced 292 tons of concentrate, containing $922 in gold, 22,000 ounces of silver, and 165,000 pounds of lead, and from one lot payment was made for 13,439 pounds of zinc. The total value of these concentrates was $20,208, or an average value per ton of $69.21. The crude ores of shipping grade sent directly to the smelter aggregated 918 tons, containing $18,607 in gold, 34,928 ounces of silver, 6,800 pounds of copper, and 226,690 pounds of lead, valued in all at $47,667, or an average value per ton of $51.92. The placer bullion produced by 12 operators amounted to $8,486 in gold and 25 ounces of silver.

[1] Smith, Lyon, Eng. and Min. Jour., Oct. 3, 1914, p. 595.

Cortez district.—Two producers reported the production of ore, most of which was taken from the Falconer group. The larger part of the output was treated in the 60-ton concentration mill of the Cortez Mining & Reduction Co., and concentrates containing lead and silver with a little gold were shipped to the smelter.

Eureka district.—The output of ore by 24 producers aggregated 807 tons, containing $18,457 in gold, 28,441 ounces of silver, 2,379 pounds of copper, 194,803 pounds of lead, and 13,439 pounds of zinc, valued in all at $42,783, or an average value per ton of $53.01. All the ore was of shipping grade, except one small lot, which was concentrated and produced zinc concentrate. Among the producers reporting were the Altoona & Wide West, Liberty, California & Silver King, Delaware, Diamond, Virginia, Dunderberg, Hamburg, Good Hope, Jackson, Laurel, Hidden Jewel, Pearl, Phoenix, and Silver Lick.

Lynn district.—From the operations of 12 placers there was produced $8,486 in gold and 25 ounces of silver, as against $1,511 in gold and 5 ounces of silver in 1913. One small production of gold was reported from a quartz mine and amounted to $78. The most important placers reporting production were the Hilltop, Bulldog, Compromise No. 10, Golder Doll, Lone Star No. 1, Mephisto, Flower Girl, Bunker Hill, Yorkshire, and Gladstone.

Mill Canyon (Buckskin) district.—An important output of gold-silver ore was treated in the 300-ton cyanide plant on the property of the Buckhorn Mines Co., which is opened by an incline shaft 270 feet deep and has a transportation tunnel 1,700 feet long and 20,000 feet of drifts and crosscuts.

Mineral Hill district.—Ore of shipping grade mined by three producers aggregated 108 tons, containing $25 in gold, 2,238 ounces of silver, 3,424 pounds of copper, and 20,381 pounds of lead, valued in all at $2,513, or an average value per ton of $23.27. The principal producers were lessees operating on the ground of the Mineral Hill Consolidated Mines Co.

Safford district.—The Zenoli property was a producer of 1 carload of oxidized lead ore containing silver and a little copper.

HUMBOLDT COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Humboldt County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	121	25,585	$318,544	757,505	17,065	61,072	$781,409
1914	94	30,569	563,485	691,778	32,952	32,495	951,688
Increase (+) or decrease (−) in 1914		+4,984	+244,941	−65,727	+15,887	−28,577	+170,279

[a] Includes placer production.

Ore produced in 1914 by 78 operators aggregated 30,569 tons and was 4,984 tons more than was reported by 114 operators in 1913. The total average value per ton decreased from $30.03 in 1913 to $29.62

in 1914. Practically all of this value is that of the gold and silver content. The greater part of the ore (15,522 tons) was of milling grade and yielded at gold and silver mills $387,102 in gold and 24,106 ounces of silver, valued in all at $400,433, or an average value per ton of $25.80. Included in this was the gold and silver bullion recovered from 110 tons of old tailings. In addition to the bullion produced, concentrates were also recovered, carrying principally gold and silver values. The ore of shipping grade amounted to 14,844 tons and contained $78,663 in gold, 646,806 ounces of silver, 2,064 pounds of copper, and 28,795 pounds of lead, valued in all at $437,745, or an average value per ton of $29.49. Placers in the county produced $45,939 in gold and 638 ounces of silver, as against $12,898 in gold and 238 ounces of silver in 1913.

Amos district.—Lessees operated the 12-ton amalgamation and cyanidation plant and produced bullion containing gold and a little silver from the property of the D. & C. Mining Co., situated 30 miles northwest from Winnemucca, in the region known as Slumbering Hills. On Tepee Creek some prospecting of the stream gravel resulted in the production of a small output of gold.

Antelope district.—Five producers reported the shipment of 135 tons of ore, containing $1,240 in gold, 2,691 ounces of silver, 20,053 pounds of lead, and a little copper, valued in all at $3,626, or an average value per ton of $26.86. The producers were the Antelope Springs and the Last Chance properties. Included in the production was the output of the Haystack property.

Disaster district.—From placer mining in the district during 1914 some gold was reported to have been produced.

Dun Glen, Central, or Chafey district.—Reports received from producers, chiefly lessees on different properties, gave an output of $2,755 in gold, 299 ounces of silver, and 2,211 pounds of lead, valued in all at $3,006. This output included a small bullion shipment supposed to have been recovered from the panning of surface ore.

Echo district.—Attempts were made, with poor success, to treat by cyanidation an old waste dump of one of the properties in the district, assaying about $4 per ton in silver, and some silver bullion containing gold was shipped.

Golconda district.—Two producers reported the shipment of silver ore containing a little gold. The old Gregg mine was operated a short time.

Gold Run district.—A clean-up of the old smelter at Golconda, which in the past treated ores largely from this district, and the production of bullion from the Golconda Gold Ledge property comprised the total deep mine output of the district in 1914. The Bonanza placer, situated 10 miles south of Golconda, was worked by shafts and bedrock drifts, dry methods, usually with rockers, being employed. A small quantity of gold was produced during this work. Some gold was also reported to have been produced from the Warren and Lazy Man's gulch placer.

Imlay district.—A small quantity of silver ore was shipped by two producers.

Kennedy district.—No production of ore or bullion was reported from the region in 1914, although a small output of bullion is credited to the district, probably from some former production.

National district.—Milling ore that yielded gold bullion and a small quantity of gold and silver concentrate were shipped from the National mine, which is equipped with a 10-stamp amalgamation and concentration mill of 50 tons daily capacity. Five stamps were added to the plant in 1914. The mine was operated continuously during the year and the mill about one-third of the time. It is reported that the Old National vein is worked out, and the new "X" vein is being opened. A small shipment of rich ore was made from the Buckskin group, the owners of which report that about 1,000 tons of ore of good milling grade have been extracted and placed on the dump ready for treatment. The geology of the district is described in Mineral Resources for 1911 and 1912, and more fully in a paper by Lindgren[1] recently published by the Survey.

New Goldfields district.—Some ore was treated in the 5-stamp amalgamation and concentration mill of the North Star property, and some gold and silver bullion and concentrates were produced in 1914.

Paradise Valley district.—A little silver bullion containing gold is reported to have been recovered from old tailings treated in the district during 1914.

Rochester district.—The total output of the district, valued at $423,478 and reported by 32 producers in 1914, was a slight decrease from the output of 34 producers, valued at $477,487, in 1913. The ore produced and reported by 24 operators aggregated 14,499 tons, containing $71,769 in gold, 621,833 ounces of silver, and a little copper and lead, valued in all at $416,045, or an average value per ton of $28.69. Placer operators reporting from 8 different sources produced $7,374 in gold and 106 ounces of silver. Nearly all the ore (14,374 tons) was shipped directly to the smelters, and 125 tons produced bullion containing gold and silver.

The Rochester Consolidated Mining & Milling Co. started work on a 100-ton all-sliming cyanide plant in the lower town of Rochester and completed the building which is to house the machinery.

A recent article[2] reviews the developments in the district as follows:

> The small mill is a 2-stamp Joshua Hendy amalgamation plant, owned by the Lincoln Hill Mining & Milling Co. It is situated in Rochester Canyon, just below the mouth of Octopus Gulch. The power is obtained from a gasoline engine, which also runs an electric generator. The water is pumped from a well in the bottom of the creek bed, from which a drift was driven on bedrock across the whole channel to develop all the water possible. This company owns two claims on the north slope of Lincoln Hill, from which it is mining gold ore, some of which runs as high as $300 per ton. A few lots of ore for lessees on Lincoln and Wilson hills have been crushed, the last lot being from the Gotham claim on Wilson Hill, owned by U. W. Harwood, which returned $67 per ton.
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> The new mill being built near the lower part of Rochester Canyon is about opposite Octopus Gulch. This mill is guaranteed to treat 100 tons per day and to make an extraction of 95 per cent, by the Dorr continuous counter-current decantation cyanide process. The power for the mill will be supplied by an electric-power line being put in by the Nevada Valleys Power Co., whose plant is at Lahontan. The water for the mill is brought by gravity from a small stream about 6 miles southeast.
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> Nenzel Hill has had the most development work done. Here are three leasing companies working on adjoining blocks of ground. They are all opened

[1] Lindgren, Waldemar, U. S. Geol. Survey Bull. 601, 1915.
[2] Min. and Sci. Press, Feb. 6, 1915, p. 230.

to the same level, which is about 500 feet deep on the dip of the vein. Large quantities of ore have been shipped from these leases, and a good tonnage of milling ore is blocked out in them, waiting for the mill to start. A new adit has been driven at about the middle of the properties as a working exit for them all. A surface gravity tramway is being constructed from this about 1,000 feet long to ore bins at what will probably be the terminus of the railroad.

Silver was the predominant metal in the ore on Nenzel Hill near the surface, while on the lower level there is quite an increase in the gold content.

About 2 miles to the south of Nenzel Hill is the Packard portion of the district, from which the richest silver ore has been shipped, and in the past three months production was $45,000.

Limerick Ridge, Wilson Hill, and Lincoln Hill have two systems of veins; those running nearly east and west are being prospected more thoroughly at the present time, containing almost free gold ore. The cross veins run about southwest and contain considerable silver, but so little work has been done that not much is known of these veins. H. C. Potter has recently taken a lease on part of the Nonpareil claim, where both systems of veins are found, and purposes to drive an adit to open the veins at their intersections. * * * Some fine specimens of free gold in white quartz have come from this part of Lincoln Hill. In the upper part of Limerick Canyon there are several miners working placer claims in bedrock drifts 30 or 40 feet below the surface. Some of the gravel is worked in dry washers, while the balance is taken about a mile down the canyon to a spring and washed.

Just across Octopus Gulch, on the southern extension of the Buck & Charley vein, the Rochester-Lincoln Consolidated Mines Co. is opening a vein in two adits. Some ore has been shipped from the upper one, and the lower is showing ore in two places.

Just to the east of the latter property are the Octopus claims, on which considerable work has been done. Nothing has been shipped from this property, but ore of good milling value is being opened.

Independence Ridge shows the ore to contain about equal amounts of gold and silver. The Buck & Charley mine has been the most developed. * * * Six men are working it under lease and have shipped considerable ore, sending out about 2 carloads per month; but now that the railroad has laid a spur track to their ore bin, they expect to increase their shipments to 5 cars. The ore averages about $40, although some of their shipments have run up to nearly $100 per ton. This is the first mine in the district to be connected direct with the railroad.

Rosebud district.—Two small shipments of silver ore were reported to have been produced in the district in 1914.

Seven Troughs district.—Ten operators, including 1 placer operator, produced 3,903 tons of ore, $295,605 in gold and 30,089 ounces of silver, with a small quantity of copper and lead, valued in all at $312,288. This output included 163 tons of ore of shipping grade containing 553.96 ounces of gold and 16,489 ounces of silver. There were also 81 tons of gold and silver concentrate shipped and 3,740 tons of ore milled, which yielded bullion containing 12,485.80 ounces of gold and 10,211 ounces of silver. The largest producer was the Seven Troughs Coalition. Smaller productions were made by the Seven Troughs Mining Co., Mazuma Hills, Signal Peak, and War Eagle claims.

According to the annual report of the Seven Troughs Mining Co.,[1] its lessees shipped 564.79 tons of ore, yielding gross $29,192.07.

The year's operations, with the exception of 100 feet of crosscutting on the 110-foot level, have been confined to leasing. There have been 22 sets of lessees working on small blocks of ground at various times. Every part of the mine has at one time or another been worked. The development work has opened up only one ore shoot of any consequence. This is a shoot of silver ore, in a block lying between the Florence and Fairview workings, in ground hitherto unprospected. Other parts of the mine have been productive in just about the

[1] Seven Troughs Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

proportions that might be expected from gleaning in old stopes. Most of the work of this kind was not profitable. The coming year more work will probably be done in real virgin ground and less in ground that has been exhausted by previous operations.

The ore bodies in general are pockets of small size. These pockets seem to occur in certain definite channels. This feature has given rise to a system of prospecting that is somewhat unique. Stopes about 4 feet wide and of various lengths are carried up and filled with broken waste; that is, prospecting is done by stopes, instead of drifts, crosscuts, and raises. The soft nature of the ledge makes this a cheap way of working, and a greater area of the vein can be searched for the small pockets. The total development work during the year is drifts and crosscuts 1,108 feet, raises and winzes 1,130 feet, stopes 32,892 square feet.

Spring Valley district.—Gold ore from a small vein at the surface was shipped from the Hazel group. There is a vertical shaft 30 feet deep on the property, and a tunnel has been driven 350 feet during the last two years. The only gold dredge said to be operated in Nevada is situated in this district on the property of the Federal Mining Co. About 135,000 cubic yards of material were treated in 1914, and produced gold bullion about 0.767 fine. Smaller quantities of metal-bearing material from the vicinity were recovered by hydraulic methods.

Trinity district.—A small quantity of gold ore was produced from the Evening Star and the Humboldt properties. The latter property is equipped with a milling plant consisting of a Huntington mill and a concentration table.

Unionville district.—The Star Peak, Tiger, and Rusty Pick properties were the producers of the output of the district, which amounted to 3,016 tons of ore. The ore from the Star Peak property was treated in the 5-stamp amalgamation mill equipped with 1 concentration table and produced gold and silver bullion and a small quantity of concentrate containing a little lead.

Winnemucca Mountain district.—Eight producers reported the production of 130 tons of ore, containing $2,812 in gold and 1,746 ounces of silver, valued in all at $3,778. Included in this is a small quantity of bullion said to have been recovered from placer operations. The Neshobe and Sunshine were the principal producers.

LANDER COUNTY.

In 1914 there were 6,473 tons of ore produced by 15 mine operators. This is 21,236 tons less than was produced by 35 operators in 1913. The total average value per ton increased from $6.21 in 1913 to $20.05 in 1914 and the gold and silver value per ton in this ore from $5.35 to $19.49. The production of milling ore amounted to 1,830 tons. Gold and silver mills produced $10,036 in gold and 12,039 ounces of silver, valued in all at $16,694, or an average recovery value per ton of $9.12 from ore only. Included in this total value is the bullion recovered from 3,000 tons of old tailings. The gold and silver mill output in 1913 was valued at $89,590, or an average value per ton of $6.62. The ore of shipping grade, amounting to 1,643 tons, contained $10,058 in gold, 179,783 ounces of silver, 7,772 pounds of copper, and 66,132 pounds of lead, valued in all at $113,091, or an average value per ton of $68.83. The placer output by 14 operators amounted to $94,503 in gold and 626 ounces of silver, as against a production in 1913 by 12 operators of $27,162 in gold and 188 ounces of silver.

Battle Mountain district.—The principal camps of the district, named from north to south, are Copper Basin, Cottonwood Creek, Galena, Copper Canyon, and Bannock. The district and some of its mines are described in a recent report[1] published by the Survey. Three deep mines and 14 placers produced 4,586.48 ounces of gold and 5,456 ounces of silver, valued in all at $98,249. There were only 55 tons of ore produced, containing gold and silver and a small quantity of lead. The larger part of the district output was from placers, which yielded $94,503 in gold and 626 ounces of silver, valued in all at $94,849. The producers of this gold operated principally in Copper Canyon and were the Dahl, Guy Davis, and Oversight placers. The deposits are worked principally by drift mining, sluicing, and rockers.

Bullion or Lander district.—Silver ore, carrying a little copper and gold, was shipped from the Maysville group.

Cortez district.—An important shipment of ore was made directly to the smelter from the Garrison property.

Hilltop district.—The Gray Eagle and the Kimberly Consolidated properties were the only producers in the district. The former property shipped directly to the smelter, and the ore produced from the Kimberly Consolidated property was milled in the cyanide plant of the Hilltop Milling & Reduction Co., producing gold and silver contained in cyanide precipitates.

Lewis district.—A small quantity of silver ore was shipped from the Topsy and Estella claims.

Ravenswood district.—This district is in the Shoshone Mountains, a few miles south of Reese River canyon. According to Hill,[2] who visited the region in 1914, small quartz veins carrying galena, tetrahedrite, and chalcopyrite, have been opened at a few prospects. The veins are found in dark-colored thin-bedded quartzites and argillites of Cambrian age. At one place some small dikes of quartz monzonite were seen, but intrusive igneous rocks are not found in the vicinity of the more important prospects. Much of the area is underlain by flows of rhyolite and andesite of Tertiary age. No production was reported from the district in 1914.

Reese River (Austin) district.—The district occupies a belt approximately 6 miles in length from north to south in the central part of the Toyabe Range. The town of Austin is situated at the center of the district, and is connected with Battle Mountain, the county seat, 93 miles distant, by the Nevada Central Railroad. A recent report[3] published by the Survey describes the geology. In 1914 old tailings and ore, containing gold, silver, lead, and a little copper, valued in all at $7,495, were produced in the district. Part of the output produced gold and silver bullion, and 15 tons of ore were shipped to the smelter. The larger part of the production was made by lessees.

Skookum district.—In 1914 silver ore containing a little lead and a trace of copper and gold was shipped from the Robert Watt prop-

[1] Hill, J. M., Some mining districts in northeastern California and northwestern Nevada: U. S. Geol. Survey Bull. 594, pp. 64–91, 1915.
[2] Hill, J. M., unpublished notes on some Nevada mining districts.
[3] Hill, J. M., Some mining districts in northeastern California and northwestern Nevada: U. S. Geol. Survey Bull. 594, pp. 95–114, 1915.

erty. A description of the district was recently published in a Survey report.[1]

LINCOLN COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Lincoln County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	22	96,555	$63,728	475,105	661,494	7,701,311	49,962	$794,879
1914	20	91,332	57,366	408,286	660,589	5,985,679	1,104,644	660,785
Increase (+) or decrease (−) in 1914		−5,223	−6,362	−66,819	−905	−1,715,632	+1,054,682	−134,094

The total output of ore in the county in 1914 amounted to 91,332 tons, reported by 20 producers, 5,223 tons less than was reported by 22 producers in 1913. The total average value per ton decreased from $8.23 in 1913 to $7.23 in 1914, and the gold and silver value decreased from $3.63 to $3.10. The ore of shipping grade predominated and amounted to 86,141 tons, containing $39,792 in gold, 394,387 ounces of silver, 660,589 pounds of copper, 5,985,679 pounds of lead, and 1,104,644 pounds of zinc, valued in all at $635,524, or an average value per ton of $7.38. In 1913 the total value of the shipping ore was $621,710, or an average value per ton of $7.43. Ore treated at gold and silver mills amounted to 3,753 tons and produced bullion valued at $15,493 in gold and 238 ounces of silver, valued in all at $15,625, or an average value per ton of $4.16. No placer output was reported in 1914.

Atlanta (Silver Park) district.—This region is situated 50 miles north of Pioche. Its mines, according to Hill,[2] who visited them in 1914, are of two types. Silver ores of the oxidized type are found in veinlike replacements of limestone of supposed Cambrian age. Free-milling gold ores are exposed in the workings of the Atlanta mine. The ore is a partly cemented iron-stained fault breccia. The faulting evidently took place after the formation of the rhyolitic tuffs of early Tertiary age. Some of the quartz replaces barite and has the characteristic slaty cellular structure of deposits formed in the "late Tertiary" period of mineralization. The ores of this district are probably the most recently formed in all the camps mentioned in this summary of mines visited by Hill in 1914.

A recent publication[3] gives an account of the activity in the district.

> The Atlanta Consolidated owns a large group of patented claims in the old Silver Park district, 45 miles northerly from Pioche. * * * The property is equipped with a steam hoist and necessary machinery, water system, electric-light plant, blacksmith shop, storehouses, assay offices, barn, boarding house, offices, and houses for a large force.
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> The rocks of the Silver Park district were originally sedimentaries, limestone and sandstone, cut by an immense dike of porphyry, and later by an in-

[1] Hill, J. M,. op. cit., pp. 92–95.
[2] Hill, J. M., unpublished notes on some Nevada mining districts.
[3] Abbott, J. W., Min. and Sci. Press, Sept. 26, 1914, p. 486.

trusion of rhyolite, which appears to have been the source of the mineral-bearing solutions, and in or adjacent to this intrusion ore bodies were found. Much of the mineral-bearing material was a more or less complete replacement in the limerock shattered by the intrusion. The ore contains both gold and silver in commercial value, gold prevailing. In the old days Silver Park had a daily 6-horse Concord coach, connecting with the outside world at Palisade, on the Southern Pacific. It had two mills, and when the Pioche mines were producing more ore than could be handled at Bullionville and Dry Valley a large tonnage was hauled to Silver Park and reduced to bullion, with a treatment charge higher than the total value of the ore now produced in any of the big mines of the United States.

Bristol district.—According to Hill[1] the silver-bearing oxidized lead and copper ores of the Bristol district are in limestones of Cambrian age. They occur as replacements of the limestone, usually at the intersection of two sets of more or less open fissures. One set of fissures strikes N. 60°–80° E., and dips 40°–50° S., and the other strikes from N. 10° E. to N. 10° W., and are nearly vertical or with steep dip, usually east, though in some places west. Limonite and pyrolusite are widely distributed in the copper ores, which carry copper pitch ore, chrysocolla, and malachite. The lead is mostly in the form of cerusite, though some anglesite and residual nodules of galena were found in a few of the ore bodies. All of the ore shipped from this particular locality in 1914 is included with that of the Pioche district.

Caliente district.—The Gold Chief property was the principal producer of gold and silver bullion, recovered from ores treated in a 50-ton cyanide plant on the property.

Comet district.—Lessees operated the Churick claims and produced lead sulphide ore, carrying silver and a trace of gold. This district is situated on the southwest side of Comet Mountain, 16 miles west of Pioche. The claims are opened by an adit 180 feet long and two shafts 90 feet and 50 feet deep, respectively. All of the ore produced was from two claims, the Dorothy and the Jennie.

Eagle Valley district.—Ore of shipping grade, containing gold and silver, was produced and shipped to the smelter from the Winner and B. & C. groups.

Patterson district.—This region is situated about 62 miles north of Pioche and 12 miles north of Atlanta. Hill[1] says that the first discovered ores were the siliceous veinlike replacement deposits in Cambrian limestone, which occur on the north side of Patterson pass. In recent years some prospecting has been done on small bodies of lime silicate rock occurring at the summit of the range at the head of Swartz Canyon. These deposits are at the base of some dark limestones, which conformably overlie shales and quartzites of Cambrian age and are near a dike of granite porphyry.

Pioche district.—Fifteen operators reported the production of 87,568 tons of ore and old tailings, all of which was of shipping grade and contained $41,752 in gold, 406,927 ounces of silver, 660,573 pounds of copper, 5,983,307 pounds of lead, and 1,104,644 pounds of zinc, valued in all at $644,325, or an average value per ton of $7.36. The larger part of the output of ore was from the Prince Consolidated, which also shipped a quantity of tailings, valuable at the smelter as converter linings. Considerable ore was also shipped

[1] Hill, J. M., unpublished notes on some Nevada mining districts.

from the Day Bristol Consolidated property, which has been in the hands of a receiver for the last two years. Important developments were made on the property operated by the Consolidated Nevada-Utah Corporation, owning the controlling interest in the Amalgamated Pioche Mines & Smelter Corporation, and an important tonnage of oxidized ores containing lead, silver, copper, gold, and some zinc was shipped. Other properties operated were the Highland Queen, Mendha, Nevada Park, Greenwood, Fortuna, and Crescent.

A recent description[1] gives in some detail of the present activities of the district, as follows:

The old Utah-Nevada and Meadow Valley properties on the hill south of town are now owned by the Amalgamated Pioche Mines & Smelters Corporation. * * * The company is operating through the old Nevada-Utah No. 1 shaft. It has revised the plant, the principal part of which is now new installation. * * * There is a pump station at the 650-foot level, and another on the 1,200, which is the water line. The shaft has been sunk to the fourteenth level, where another pump has just been placed with a deep sump below. * * * A crosscut 135 feet long was driven from the bottom of the shaft to the old Raymond & Ely twelfth level, above which there is a considerable body of zinc ore. Another crosscut was run from the 1,400-foot station and cut the Raymond & Ely fissure 18 inches wide. A drift has been run to the westward on the fissure, and it is expected that that drift will cut the old Raymond & Ely Black Ledge within 600 feet from the crosscut. No reliable maps of those old deep workings are known to exist, and it has been necessary to make provision for the water collected in the winze, which was sunk in the early days on the Black Ledge. * * * On the twelfth level a narrow vein of siliceous ore has been opened which sampled 1.34 ounces gold. The drift on the 1,400-foot level has opened a body of mineralized material, 7 feet wide, some of which carries much native silver in lead and zinc sulphide. This body of ore is believed to indicate the approach to the famous old Black Ledge. * * * At present the Pioche Amalgamated is shipping at the rate of about 300 tons per month. * * * Much of the ore now mined will not be taken to the smelters, but will be held for treatment in a mill to be erected later. * * * The Yuba Leasing Co. has a lease for a period of five years, and covers all the company's property on the Yuba dike and 1,000 feet of the old Meadow Valley fissure. * * * A long shoot of ore, running high in gold, with some silver and lead, was found on the 900-foot level; also several shoots in the old Yuba dike workings, which were opened by a crosscut from the 900-foot level, 360 feet south. * * *

As a result of a complicated series of negotiations; the Amalgamated Pioche now controls the old Ohio-Kentucky, which included the Greenwood. Lessees have recently shipped some high-grade gold ore from the Greenwood mine. The ore shoot in the part of the mine from which this gold ore was taken is doubtless an extension of the old Panaca vein of the Raymond & Ely.

Several years ago the old Day mine, which, as the Jack Rabbit, in 1877 produced a vast amount of phenomenally rich ore, and the old Bristol Consolidated properties on the Bristol side of the range were consolidated into a corporation which was known as the Day-Bristol Mining Co. The Day mine has not been worked for a long time, but the Bristol side of the range has been quite active. Mining operations on that side were conducted at great handicap because of very expensive wagon haul, averaging probably $6 or over per ton, from the mine to the Pioche-Pacific Railroad at Jack Rabbit. To obviate this wagon haul, the Day-Bristol last year contracted * * * to build an aerial tramway. * * * The properties of the Day-Bristol Consolidated have for a year or more been operated entirely by lessees. * * * The different properties on the Bristol side, which have been operated by lessees, are the Hillside, Tempest, Iron Mine, National, Vesuvius, and Geyser.

The Mendha-Nevada, whose history goes back to the very beginning of * * * the Pioche district, last year built a concentrator to treat its second-class ores. The company has been shipping about 2 cars of concentrate per week. * * * The old Half Moon mine, about 3 miles on a straight line southwest from Pioche, has recently been worked on a lease by A. T. Godbe, who has shipped

[1] Abbott, J. W., Present conditions at Pioche, Nev.: Min. and Sci. Press, Sept. 26, 1914, p. 483.

not only many cars of tailing, but also several cars of ore yielding more than one-half ounce gold, in addition to silver and lead. The Half Moon is a bedded vein which was worked during the early years and the ore treated at the old Phoenix smelter. It was regarded then as a very valuable piece of property if the ore could be locally treated. A concentrator was erected on the premises and a large quantity of concentrate was made and locally treated, but the enterprise did not pay and was abandoned, the property being acquired by the Nevada-Utah. Recently the mill building and contents, including crushers and concentrating table, were hauled away from the Half Moon to the Gold Chief property in the Chief district, about 25 miles easterly. The Gold Chief ore contains principally gold. Several years ago a cyanide plant was erected at the Gold Chief mine, which was idle for a long time. It has recently been in operation, and about 500 tons of ore has been treated, with an average extraction of about $6, leaving from 80 cents to $1 per ton in the tailing.

Another enterprise of promise to the Pioche district is the Alps Mining Co. * * * The Alps in the closing days of Pioche's first period was a mine of great promise. It had already produced several hundred thousand dollars under the conditions then existing. It had, in addition to the principal vein, of which the value was mostly in silver, another which produced the most beautiful free gold ever sent from that district. The old Alps owned the Floral mill, situated between the present center of Pioche and the railroad depot. Lessees have recently shipped the tailing from this old Floral mill and have done well. * * * The Pioche-Pacific Railroad, 14 miles in length, from Pioche to the Day mine at Jack Rabbit, was in the hands of a receiver for considerably over a year. Last October it was released from the receivership and has managed to exist from the receipts of ore hauled from the various leases on the Day-Bristol and vicinity. * * *

The most active mine in this district to-day, and the one at present of most promise for the future, is the group owned and operated by the Prince Consolidated Mining Co., situated about 3 miles southeasterly from Pioche. The ore in the upper 300 feet consists of an argentiferous iron manganese, carrying a little lead, the ore body being a replacement in limestone. Below are found numerous beds of shale, and cutting the formation are two approximately vertical veins of ore high in silver and lead. The company owns a standard-gage railroad, about 9 miles long, from the Pioche depot on the Salt Lake line to the mine, over which more than 100,000 tons of ore has already been shipped, the present production being from 200 to 300 tons of ore per day. This production can be maintained for many months without additional development. In addition to the mine, the company owns tailing dumps at Bullionville and Dry Valley, which it is estimated are good for $400,000 when the company is ready to dispose of them. It was from the tailing at Bullionville that the money was obtained to build the railroad. The mine is at present operated through an incline shaft to a little below the 500-foot station, which is about water-level. * * * The ore, when mined, is dropped to the 400-foot level and from there hoisted to the surface. * * *

The Virginia-Louise Mining Co. * * * is developing the Virginia-Louise mine, which covers the extension of the Prince on the south.

LYON COUNTY.

Forty-seven producers reported the output of 112,716 tons of ore in 1914; this was 97,573 tons less than was reported by 52 producers in 1913. The total average value per ton of the ore decreased from $11.34 in 1913 to $9.20 in 1914, and the gold and silver value in this ore increased from 20 cents per ton to 61 cents. The greater part of the ore mined was of shipping grade and aggregated 102,480 tons, containing $7,832 in gold, 6,413 ounces of silver, and 7,274,329 pounds of copper, valued in all at $978,864, or an average value per ton of $9.55. In 1913 the total value of the shipping ore was $2,346,758, or an average value of $11.34 per ton. At gold and silver mills bullion and a small quantity of concentrates were produced. Altogether 4,016 tons of ore were treated, which yielded $49,866 in gold, and 11,939 ounces of silver, valued in all at $56,468. Included

in this bullion was the gold and silver recovered from 6,220 tons of old tailings. The output of gold and silver mills in 1913 was valued at $37,562, an average value per ton of $10.97. No placer production was reported.

Silver City district.—Twenty-six producers reported the production of 10,249 tons of ore, including some old tailings. There were 19 tons shipped crude. The milling ore produced gold and silver bullion. Part of the ore produced from the mines in the district was treated in the Silver City Gold & Silver Milling Co.'s plant, equipped with a 4-foot Bryan mill and amalgamation process. Most of the ore produced in the district was mined by prospectors and lessees from various properties, and was milled in custom plants.

The Metals Recovery Co., at Dayton, completed a cyanide plant of 200 tons daily capacity late in 1914 to treat some 250,000 tons of old Comstock mill tailings. Various attempts to treat these tailings have been made from time to time, but owing to the high percentage of cupric oxide associated with the silver and gold all these efforts failed to obtain commercial results. The copper is dissolved out of the tailings by agitation in Parral acid-proof tanks in sulphuric acid solution, the solution decanted, the pulp washed and transferred, being treated in a second series of Parral agitating tanks by a lime wash en route which neutralizes the residual acid in the pulp. The pulp is then agitated in a cyanide solution in the second series of Parral tanks, in which a high extraction of the gold and silver is effected in an unusually short time.

Yerington district.—The Mason Valley and the Nevada Douglas were the two largest producers in 1914. Altogether 21 producers reported the output of 102,467 tons of ore, all of which, with the exception of one small lot producing bullion, was treated at the smelter at Thompson, and contained $7,091 in gold, 5,746 ounces of silver, and 7,274,329 pounds of copper, the whole being valued at $977,754, or an average value per ton of $9.54.

Mining at the Mason Valley mine[1] and operations at its smelter at Thompson were discontinued in October on account of the demoralized condition of the copper market and the consequent closing down of properties from which a large part of the custom ore at the smelter was derived.

The company's annual report says:

> The tonnage smelted from January 1, 1914, to October 20, 1914, was 142,197 tons, of which 75,038 were from the company's property and 67,159 tons custom ore.
>
> From the above ore there was produced and shipped 212 tons of copper matte and 4,542 tons of blister copper, containing 9,127,974 pounds copper, 11,553.13 ounces gold, 221,151.29 ounces of silver.
>
> There has been no new mining property acquired by the Mason Valley Mines Co. during the year. A great deal of exploration and development work has been done on outside properties at points tributary to the smelter. Leases and options were secured upon a number of properties which gave promise of developing an ore tonnage, but upon the whole the results were disappointing. Some ore was developed and shipped from the Anderson property at Luning and the Montana Yerington property near Yerington, but the amount of ore developed did not justify the purchase of the properties and the options were dropped.
> * * *

[1] Mason Valley Mines Co. Fifth Ann. Rept., for year ending Dec. 31, 1914.

The greater part of the development work during the year has been done in the east ore body. This ore body is east of and parallel to the main ore zone, and stoping was in progress in this ore at the time the property was closed down. The east ore body, while not as extensive or as wide as the main ore body, will produce considerable tonnage. * * *

There has been no addition to the smelter property or equipment during the year except the completion of the converter plant. * * *

Smelting costs averaged lower during the period of operation in the year than the year previous, although a less tonnage was treated. This was largely due to a lower delivered price for coke and on account of the use of less limestone flux, made possible by the smelting of California iron sulphide ores and the addition of converter slag to the blast-furnace charge.

The purchase of California sulphide ore from Shasta County properties was begun the latter part of 1913, and the use of this ore in combination with Mason Valley and other local ores was so satisfactory that arrangements were made with several California producers for regular tonnages. * * *

The customs ore shipments to the smelter were almost entirely discontinued during August and September. The smelter could not be operated economically upon Mason Valley ore alone, and it was therefore decided to smelt up the ore and by-products then on hand and close the works. The Mason Valley mine continued shipments until October 15, the ore being necessary to flux the other ores and by-products on hand. Smelting operations were discontinued October 20. This was the first interruption since the starting of the smelter January 6, 1912.

The converting plant was started January 3, 1914, and since that time the matte was converted to blister copper, which was shipped direct to the refinery in the East. This made a large saving in treatment charges and freight.

According to the last annual printed report of the Nevada Douglas Co.[1]—

Shipments were continued throughout the years 1912, 1913, and 1914, until about September 1. The net result from these shipments has been that on the 1st of September, 1914, the company's indebtedness had been reduced to $442,541.03, in addition to paying one dividend in the early part of 1913, amounting to $117,236.01. At this time the smelting plant of the Mason Valley Mines Co., which had been our sole market for ores, was closed down, on account of lack of a market for copper. * * *

After building two or three experimental plants and making exhaustive experiments with from a few hundred pounds up to one ton of ore at a charge, we have found that our process is particularly adapted to our needs and will, if it is as successful on a large scale as it is on a small scale, make us a greater margin on a 2-per-cent ore than on a 5-per-cent ore shipped to the smelter. * * *

The mill under construction will have a daily capacity of 250 tons. Fifty tons of this ore will be sulphide and 200 tons oxidized ores, the 50 tons of sulphide furnishing the acid necessary for the treatment of 200 tons of oxidized ore.

All the grading and foundation work for the plant is completed (March, 1915). Large ore bins have been constructed with a capacity of 600 tons.

Other properties producing were the Empire & Copper Flat groups, Gold Crown, McConnell, Mohawk, Panama, Copper Ridge & Reef group, and Malachite.

MINERAL COUNTY.

Ninety-nine operators reported the production of 76,157 tons of ore, which was 46,823 tons more than was produced by 83 operators in 1913. The total average value per ton decreased from $13.12 in 1913 to $6.79 in 1914 and the gold and silver value per ton in this ore from $8.96 to $6.33. The greater part of the ore produced in the district (63,065 tons) was treated at gold and silver mills and

[1] Nevada-Douglas Consolidated Copper Co. Ann. Rept. for year ending Mar. 4, 1915.

produced bullion containing $323,097 in gold and 129,610 ounces of silver, valued in all at $394,771. Included in this bullion output is the gold and silver recovered from the treatment by cyanidation of 9,876 tons of old tailings. The ore of shipping grade amounted to 3,216 tons and contained $45,737 in gold, 64,884 ounces of silver, 240,911 pounds of copper, and 60,800 pounds of lead, valued in all at $116,029, or an average value per ton of $36.08. In 1913 the total value of the smelting ore was $197,068, or an average value per ton of $14.90. The placer yield of seven producers amounted to $5,366 in gold and 178 ounces of silver, as against an output in 1913 of $170 in gold and 10 ounces of silver.

Aurora district.—This district was recently described by Hill.[1] Five producers reported the production of 45,169 tons of ore in 1914. The larger part of this output was ore from the Humboldt property of the Aurora Consolidated Mines Co. This property is opened by an adit 2,300 feet long, and in 1914 an electric haulage system was installed. All levels were opened and put in shape to produce 500 tons of ore a day. The mill is equipped with 40 stamps, 6 tube mills, and cyanide plant having gyratory breakers, 1,460-pound stamps, tube mills 6 by 16 feet, Dorr agitators and settlers, and Merrill precipitation and filtering device. The mill was started on July 6 and ran continuously except for the usual minor stoppages. The ore, a hard quartz, averages about $5 a ton in gold and silver, chiefly gold. A new 10-stamp mill with 1,250-pound stamps, driven by electric power, was erected during the year, and ore from the Lady Jane property was treated. The mill was first intended for the treatment of ores from the Hypo claim. A considerable quantity of old tailings yielding gold and silver was treated in the Baldwin cyanide plant.

Bell district.—This district is situated at the northwest end of the Cedar Hills. Production was reported in 1914 from the Ideal group, equipped with a cyanide plant.

Belleville or Columbus district.—A small quantity of lead sulphide ore carrying silver and gold values was shipped from one property in the district. A cyanidation plant of 100-tons capacity was erected in the district the latter part of July to treat the Belleville tailings. In the Columbus district the principal producers were the Bi-Metallic, Lucky Bill, and Argentum. Although 12 producers reported an output of 560 tons of milling ore, containing gold and silver, and 597 tons of shipping ore containing principally silver and some lead, copper, and gold.

Buena Vista or Oneota district.—Ore produced from the Indian Queen and one other property in the district in 1914 carried principally silver values, some lead, and a little copper.

East Walker or Mount Grant district.—A small quantity of ore from the Robinson claim was treated at the Davidson 2-stamp mill equipped for amalgamation. This prospect is opened by an incline shaft 95 feet deep and has 50 feet of drifts. It was reported that the mining property was abandoned the latter part of the year. A report received from the owner of the Silver State mine mentioned the treatment of gold bullion in a 2-stamp amalgamation mill.

[1] Hill, J. M., Some mining districts in northeastern California and northwestern Nevada: U. S. Geol. Survey Bull. 594, pp. 141–150, 1915.

Gold Range district.—A small quantity of copper oxidized ore containing a little silver was shipped to the smelter from the Blue Jacket group. The property is opened by two inclined shafts 50 feet and 60 feet deep.

Hawthorne district.—Eight operators reported the production of 305 tons of ore, the larger part of which was of milling grade, yielding gold and silver bullion, and 70 tons of ore containing gold, silver, and lead, were shipped directly to the smelter. Among the producers were the Mountain View, Utah, and La Panta claims.

Klondike district.—Six producers reported 79 tons of ore containing $399 in gold, 3,596 ounces of silver, and a little copper, valued in all at $2,445, or an average value per ton of $30.95

Mountain View district.—Copper ore carrying very little silver was shipped to the smelter from the Yerington Mountain Copper property, which is opened by a vertical shaft 540 feet deep.

Pine Grove district.—The district is situated in the northwestern part of Mineral County, about 17 miles in an air line south-southeast of Yerington, the largest town in Mason Valley. The settlement of Pine Grove is 4 miles east of the Mineral-Lyon County line on the abandoned Lobdell Summit road between East Walker and West Walker rivers. The district is most easily reached from Yerington, on the Nevada Copper Belt Railroad, which joins the Southern Pacific at Wabuska. The topography, geology, and history have been discussed in a recent publication[1] of the Survey.

In 1914 there were 1,600 tons of ore and old tailings treated, which produced gold and silver bullion, and some concentrates containing copper from three properties in the district. The old Wilson mine was operated by lessees a short time, and work was also carried on at the Wheeler gold property.

The Rockland mine,[2] situated about 3 miles southeast of Pine Grove, is presumably of the same type of ore deposits as the Wheeler and Wilson mines. The mine was discovered in 1868 by a prospector named Keene, who had been working in the Wilson mine at Pine Grove, which at that time was producing high-grade gold ore and supporting a large number of leases.

According to E. J. Schrader,[3] the manager of the Rockland mine—

> The point of discovery was at the peak of Rockland Mountain, at an elevation of about 8,500 feet, and Keene traced the ledge down the south side of the mountain and started a short adit on an ore shoot exposed about 400 feet below the summit of the mountain. The ore was first hauled to Pine Grove and was said to have plated about $40. About 1870 Keene erected a 10-stamp mill in Keene Canyon, about 1 mile north of Rockland, but after a few months the mill was destroyed by fire.
>
> Some years later the mine came into the possession of Gov. Blasdell, and after doing considerable development work he erected a 10-stamp mill near the mine and also used pan amalgamation, or the Washoe process, which had been developed on the Comstock. Most of the ore taken out was mined by Blasdell, but the recovery was not high, as the tailings from his mill assay about $7. After Blasdell's death the mine was operated by leasing for a number of years, but finally carelessness resulted in serious damage by fire and work stopped for a long term of years.
>
> In 1902 the mine was acquired by the Nevada Chief Mining Co., which erected a 5-stamp mill near the Blasdell plant and also put in concentrators.

[1] Hill, J. M., op. cit., pp. 133–141.
[2] Idem, p. 140.
[3] Pittsburg-Dolores Mining Co.'s mill at Rockland, Nev.: Eng. & Min. Journal., Apr., 10, 1915, p. 653.

Finally it added a 15-ton cyanide plant for leaching tailings from plates. The total recovery was about 70 per cent. The best ore contains but little free gold, and fine grinding is necessary to recover the values by cyanidation.

A few years later a further reorganization took place, and in 1907 a 60-ton dry-crushing and leaching plant was erected. The 5-stamp mill was wrecked and much of the machinery and lumber used in the new mill. Two sets of 14 by 27 inch Humphry rolls were used for grinding, but the product was too coarse (80 per cent through 10 mesh), and the assay books show that less than 50 per cent was recovered. The tailings from the plant ran a little less than $5 per ton. No slimes treatment was attempted and leaching was done in 5 by 30 foot steel tanks. Since the old 5-stamp mill was no longer in shape, the mine shut down and was idle until 1912, when it had been acquired by the Pittsburg-Dolores Mining Co. It is difficult to get an accurate estimate of the gross production up to this time, but locally this is placed at about $500,000.

The new owners had several difficulties to overcome. Wood for fuel is not plentiful, and what timber there is should be used for stulls. The extension of the power line of the Truckee River General Electric Power Co. from Pine Grove to Rockland solved this problem and will result in the saving of thousands of dollars annually, in addition to which it will leave mine timber enough to last for many years. * * *

By building several miles of new and larger pipe lines, and driving tunnels to drain the springs at depth, the water shortage was overcome. Tests on the ore were made by the California Ore Testing Co., by Henry Wood & Co., and by the Dorr Cyanide Machinery Co., and all of them indicated that the ore was ideal for cyanidation if sliming was used. Consumption of cyanide is low and the ore settles readily. An extraction of 95 per cent should be obtained without great difficulty.

During the winter of 1913–14 a storm wrecked the old leaching plant, although the tanks were not injured, and an entirely new cyanide addition to the old mill was constructed during 1914. The management plans to use the rolls that were in the old mill and the coarse-crushing end will remain practically the same, but crushing in solution will be followed, instead of dry as formerly. For fine grinding a 5 by 18 foot Allis-Chalmers tube mill will be used. * * *

The ores at Rockland are found in a fissure vein that was formed by the intrusion of a large rhyolite dike in granodiorite. Rising hot solutions deposited a quartz-carrying auriferous pyrite and at the same time so altered the footwall and deposited quartz in fractures and seams in it that the pay ore is much wider in places than the width of the original fissure. The ore is easy to mine, and on account of the strong and hard hanging wall little timbering is necessary. The average dip of the vein is 40°, and on the lowest level a depth on the vein, below the highest outcrop, of 1,300 feet has been attained. All the development work consists of tunneling and raising. * * * About 12,000 feet of development work has been done.

Rand district.—Gold and silver aggregating $18,324 was contained in 227 tons of ore shipped to the smelter. The principal producers operated in the district were the Lost Hope and Lake Shore properties.

Rawhide district.—Twenty-four deep-mine operators reported the production of 18,279 tons of ore, containing $155,524 in gold and 105,607 ounces of silver, valued in all at $213,925, or an average value per ton of $11.70. The larger part of the ore was treated by the cyanidation process, and 115 tons of higher grade carrying gold and silver were shipped to the smelter. The principal properties worked were those of the Nevada New Mines Co. and the Black Eagle group; there were also smaller productions from the Bullskin, Diamond Fraction, Golden Pen, and Mascot. Placer gold recovered from surface mining of erosion material from quartz veins amounted to $4,171 in gold and 148 ounces of silver. Most of this gold was recovered by "dry washing."

Santa Fe district.—Ore produced from 19 properties aggregated 1,426 tons, which included a small lot yielding bullion. With the ex-

ception of this, all the rest of the ore was of shipping grade. The ore contained $663 in gold, 4,315 ounces of silver, 190,193 pounds of copper, and 1,240 pounds of lead, valued in all at $28,393. This total includes a small quantity of gold bullion from a little surface mining. The principal producers were the Never Sweat, Iroquois Copper, High Ore, Aviator, and Anderson properties. Included in the district output is a small shipment from the Del Monte Silver State mine. This district and its mines have been recently fully described by Hill.[1]

Silver Star district.—Eight operators reported the output of 296 tons of ore containing $3,754 in gold, 2,365 ounces of silver, 38,634 pounds of lead, and a little copper, valued in all at $6,695, or an average value per ton of $22.62. The bulk of the ore, or 185 tons, was of shipping grade and 111 tons produced gold and silver bullion. Among the principal producers in 1914 were the Ipswich, Black Cat, and Bird Song properties. The district and mines are fully described in a recent report[2] published by the Survey.

Sulphide district.—A small quantity of bullion was produced from the Tango claim in the district and shipped to the Pamlico mill as a test for future production. This district is situated 18 miles southeast of Hawthorne, 3½ miles east of Whiskey Spring.

Walker Lake district.—The Silver Bar property produced a small quantity of gold ore of shipping grade.

NYE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Nye County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	133	696,779	$3,537,799	11,634,033	1,925	28,563	$10,566,310
1914	123	629,970	3,377,262	11,424,769	3,262	13,290	9,696,111
Increase (+) or decrease (−) in 1914		−66,809	−160,537	−209,264	+1,337	−15,273	−870,199

[a] Includes placer production.

Eighty-four producers reported an output of ore of 629,970 tons, 66,809 tons less than was produced by 98 operators in 1913. The total average value per ton of the ore increased from $14.78 in 1913 to $15.05 in 1914. Practically all of this value is that of the gold and silver content. The bulk of the ore was treated at gold and silver mills and yielded $2,852,196 in gold and 10,074,635 ounces of silver, valued in all at $8,423,469, or an average value per ton of $13.59. In 1913 the total value of the gold and silver mill output was $8,784,304, or an average value of $12.86 per ton. Included in the output of bullion in 1914 was the gold and silver recovered from 9,522 tons of old tailings. There were 4,437 tons of sulphide concentrates recovered from the ores treated at the gold and silver mills in 1914, which yielded $290,204 in gold and 1,324,320 ounces of silver, valued

[1] Hill, J. M., Some mining districts in northeastern California and northwestern Nevada: U. S. Geol. Survey Bull. 594, pp. 157–171, 1915.
[2] Idem, pp. 171–181.

in all at $1,022,553, or an average value per ton of $230.46. The ore of shipping grade produced in the county aggregated 669 tons, containing $20,576 in gold, 19,936 ounces of silver, 3,262 pounds of copper, and 13,290 pounds of lead, valued in all at $32,553, or an average value per ton of $48.66. In 1913 the ore of shipping grade was valued at $241,869, at an average value per ton of $39.55. The placer production amounted to $213,851 in gold and 4,786 ounces of silver, as against a production in 1913 of $260,472 in gold and 5,867 ounces of silver.

Bellehellen district.—The Clifford mine was worked during eight months of 1914, and on account of shortage of water the 2-stamp Tetrault mill with concentrating table was not operated continuously. There was a new shaft sunk on the property 60 feet deep and some drifting was done.

Belmont district.—A small lot of ore was shipped as a test from one property and contained principally silver.

Bruner section.—Some gold ore was produced from the Phonolite Paymaster group, which is opened by a vertical shaft 190 feet deep and has 1,200 feet of drifts.

Bullfrog district.—Ten producers mined 2,167 tons of ore, yielding $39,320 in gold and 2,670 ounces of silver; one lot contained a little copper. The metals were valued in all at $40,813, or an average value per ton of $18.83. In addition to this output, one operator of a surface mine reported a small quantity of gold and silver bullion. The principal operations were carried on at the Pioneer Consolidated mines, where the ore was treated in an amalgamation and cyanide mill on the property and produced gold and silver bullion which netted the company $24,706. Lessees were active on several other properties, reporting small productions. A combined stamp mill and cyanide plant was built during the year by the Sunset Mining & Development Co. at Rhyolite with a capacity of 2,000 tons a month. There are 10 stamps weighing 1,050 pounds each, tube mills, amalgamation plates, classifiers, thickeners, and Pachuca tanks. Zinc shavings are used for precipitating the gold.

Cloverdale or Republic district.—A small quantity of lead ore carrying silver and gold values was reported from two properties in the district.

Currant district.—The Shepherd property was operated and several shipments were made of ore containing principally gold but also a little lead and copper.

Ellendale district.—Some gold and silver bullion shipped to the mint was reported to have been recovered from ore produced in the district from one property.

Fairfax district.—The Chickasaw and Rhyolite claims were operated by lessees and yielded a small quantity of silver ore containing gold.

Fluorine district.—Gold ore was shipped from the Bull Moose property, and a small quantity was treated at an amalgamation plant.

Hanapah district.—A small production of silver ore was reported shipped from one property in the district.

Hot Creek district.—A small quantity of gold-silver ore containing copper was reported to have been shipped from one property in the district.

Johnnie district.—The Johnnie mine was not operated during 1914, but a small production of gold bullion, probably from earlier production, was reported from one property in the district.

Lodi Valley district.—Three operators reported the production of a small quantity of gold ore and silver ore. The principal output was gold ore from the July group.

Manhattan district.—The output of ore and bullion reported by 24 deep mines and 31 placer-mine producers was valued at $276,078, as against an output in 1913 valued at $455,079. In 1914 there were 39,746 tons of ore produced, the larger part of which (39,625 tons) was milled and produced gold and silver bullion and one small shipment of concentrate containing gold and silver. In addition to this, 121 tons of gold ore were shipped directly to the smelter. The total ore mined contained $143,002 in gold and 2,548 ounces of silver, valued in all at $144,411, or an average value per ton of $3.63. The total placer bullion amounted to $130,371 in gold and 2,323 ounces of silver, as against a production in 1913 of $166,622 in gold and 3,104 ounces of silver. The deep-mine output in 1913 was valued at $286,582, or an average value per ton of $6.19. The largest output of ore was mined from the Mayflower and Big Pine property, for which a new 200-ton mill was built consisting of Blake crusher, one 5 by 20 foot tube mill, 3 plates, and 9 Dorr classifiers. This plant was started December 19, 1914. Ore from the Riley Fraction and Crescent claims was treated in the 300-ton amalgamation mill (formerly War Eagle) of the Commercial Mines & Milling Co. The Associated mill was leased to the Manhattan Consolidated Mines Co., and ores from the properties of this company, as well as ore mined by lessees, were treated. Among the other producers were the Dexter White Caps, Chipmunk, Union No. 2, Liberty Fraction, Union No. 9, Manhattan Earl, and Seyler-Humphrey. Among the placers producing were the Polaris, Dexter No. 14, Union 4 and 5, Wolftone, Copenhagen, Morning Star, Pedro, Rainbow, Robust, Bright August, San Antone, September, Sunrise, Smuggler, Top Knob No. 2, Jumbo, Gold Nugget, Evening and Morning Star, Fairview, Edith and Arlington, African, and Central City.

At the Dexter White Caps property[1] both oxidized and sulphide material was marketed.

According to the statement of the company—

> The ores mined during the year consist of 740 tons of sulphide ore extracted during development and placed on ore dump. The assays show that this ore averages $17.94 per ton, a gross of $13,279. Three carloads of sulphide ore were extracted and sold to sampler, weight 120.3 tons, average $36.88 per ton, gross of $4,454.82. During 10 days in October, all of November, and 5 days in December, we extracted and milled locally, in mill leased by the company, operating the upper portion of the mill for but one shift each day, 1,022 tons of oxidized ore, average $8.74 per ton, gross $8,933.50, making a total for the ores mined during 1914 of 1,882 tons, average $14.17 per ton, gross values of $26,667. Since the 1st of January, 1915, the mill is treating White Caps ores exclusively and good profits are shown, an average of over 50 tons per day being maintained. * * *
>
> This mill is of the conventional type, 10 stamps, tube mill, and cyanide plant, and was built for the purpose of treating ores mined by the White Caps Leasing Co. and ore from the Manhattan Consolidated Co.'s property. It is situated on the Consolidated Co.'s property, some distance from the White Caps.
>
> Experience has proved that this mill is absolutely inadequate and not at all suited for treating the White Caps ores. We have repeatedly advised you

[1] Dexter White Caps Mining Co. statement to stockholders for the year 1914.

of the refractory or base character of our ore, and exhaustive experiments and those trials have shown that some process entirely different from the one employed in this mill is necessary to successfully treat the rebellious ores of your property.

Some of the oxidized ore has been treated quite satisfactorily, but the oxidized ore is being exhausted in present operations, and the imperative problem now is to provide some means to treat the refractory ore, of which there is a large tonnage.

Milletts district.—A small production of oxidized lead ore, containing gold and silver, was shipped from the Fluorine property in 1912.

Round Mountain district.—The output of 4 deep mines and bullion recovered from 6 placers aggregated $386,067. Ore aggregating 51,066 tons was treated, principally by amalgamation. The Round Mountain Mining Co. and the Blue Jacket properties were the principal producers. The Sunnyside placer of the Round Mountain Mining Co. produced the largest output of placer gold recovered in the district. The operations of the Round Mountain mines[1] for two fiscal years are given in one report.

The report says:

During the year ending March 31, 1914, the mines produced 57,187 tons of ore, milled at the plant of the Los Gazabo Mill Co., of an average value of $5.28 per ton. Tailings losses amounted to $0.725 per ton, leaving a net recovery of $4.55 per ton, which represents an extraction of 86.1 per cent of the values contained in the ore.

During the year ending March 31, 1915, the mines produced 48,230 tons of ore, sent to the mill, of an average value of $6.57 per ton. Tailings losses were $0.87 per ton, leaving a net recovery of $5.70 per ton. The extraction for this year represents a saving of 86.8 per cent of the value of the ore. * * *

From April 1, 1913, to March 31, 1914, 133,570 tons of ore and waste were hoisted or trammed to the surface. Of this amount 57,187 tons of ore were sent to the mill, and 76,383 tons of waste placed on the dumps. * * *

The development work performed during the year ending March 31, 1915, represents an increase of 534 feet over the preceding year. After the settlement of the litigation in August, 1914, a new plan of development work was inaugurated in order to open up the Los Gazabo and Keane veins at greater depth. The main incline shaft was sunk 231 feet at a cost of $11.97 per foot. Its total depth is now 1,009 feet. The 800 level was connected with the shaft, a station cut, and loading pockets installed. At the same time the drift was extended into Sphinx territory and connected with the Sphinx workings, opening up considerable ground for stoping. * * *

The Round Mountain Mining Co. is about to enter upon a new period of its history, and will engage actively in placer mining. A careful consideration of all the factors involved has led to the conclusion that the large areas of placer ground on its property may be mined with promise of large net returns. Placer operations, conducted by lessees from 1906 to 1915, resulted in a gross production of $339,583.13 from the hydraulicking of 218,818 cubic yards of dirt, representing an average value of $1.55 per yard. * * *

An ample water supply is assured, and based on the maximum capacity of the line, it is estimated that from 1,000 to 1,500 yards of dirt per day will be washed. Measurements of flow indicate that the pipe line will operate to full capacity four or five months of the year, and that there will be sufficient water during the remaining months to carry on placer operations on a reduced scale. During the low-water season it is planned to work the shallower deposits.

The mill has been in continuous operation, excepting time lost, because of intermission in power service and holidays. The plant is in an excellent condition, several minor improvements having been made resulting in more economical operation. The Akins classifier and Hardinge conical pebble mill, installed in July, 1913, are giving good results. Three new amalgamating tables were installed below the Hardinge mill.

[1] Round Mountain Mining Co. Eighth and Ninth Ann. Repts., for two years ending Mar. 31, 1915.

Silver Bow district.—Two small productions of silver ore were reported to have been shipped to the smelters from this district in 1914.

Tonopah district.—From the year 1904 to the end of the year 1914 there was produced in this district 3,342,127 tons of ore, containing $19,262,779 in gold, 87,991,576 ounces of silver, 12,113 pounds of copper, and 214,523 pounds of lead, valued in all at $69,895,046. The copper and lead are from properties closely adjoining the district. Dividends paid by Tonopah mining companies to date amount to $21,063,061, including $3,013,803 paid in 1914. The total production is shown by years in the following table:

Ore sold or treated in Tonopah district, Nye County, Nev., in 1904–1914, number of producers, and total content of gold, silver, copper, and lead.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	10	22,703	$386,526	2,119,942	.....	.....	$1,594,893
1905	12	91,651	1,206,345	5,369,439	.....	.....	4,449,486
1906	9	106,491	1,304,677	5,697,928	.....	.....	5,122,289
1907	10	214,608	1,183,628	5,370,891	5,939	195,508	4,739,966
1908	13	273,176	1,624,491	7,172,396	.....	.....	5,425,861
1909	9	278,743	1,400,361	7,872,967	1,784	1,488	5,494,600
1910	18	365,139	2,303,702	10,422,869	942	6,902	7,932,475
1911	19	404,375	2,366,495	10,868,268	.....	.....	8,126,677
1912	17	479,421	2,223,878	10,144,987	14	700	8,463,079
1913	32	574,542	2,613,843	11,563,437	1,150	9,001	9,598,733
1914	23	531,278	2,648,833	11,388,452	2,284	924	8,946,987
Increase (+) or decrease (−) in 1914...		−43,264	+34,990	−174,985	+1,134	−8,077	−651,746

The total value of the district output by 23 producers in 1914 amounted to $8,946,987, as against an output by 32 producers in 1913 amounting to $9,598,733. The quantity of ore decreased from 574,542 tons in 1913 to 531,278 tons in 1914. The total average recovery value per ton of the ore produced was $16.84, against an average recovery value per ton of $16.71 in 1913. The largest part of the ore mined (526,572 tons) was treated by cyanidation, with and without concentration, and produced bullion containing 114,068.88 ounces of gold and 10,054,025 ounces of silver and also 4,433 tons of sulphide concentrate, which contained 13,984.76 ounces of gold and 1,321,833 ounces of silver. The average bullion recovery per ton of the ore cyanided was valued at $15.04 and the average value of the concentrates per ton was $230.10. Shipping ores amounted to 253 tons, containing 62.66 ounces of gold, 11,502 ounces of silver, 2,284 pounds of copper, and 924 pounds of lead. The copper ore originated from the Florence claim, 3 miles northeast of the Liberty mine, and the lead came from the Highland lease. Shipping ores amounted to $7,994 in value, or an average value per ton of $31.60. There were also 4,453 tons of old tailings re-treated that contained a small quantity of gold and silver. The principal properties producing were the Tonopah-Belmont, Tonopah Mining, Tonopah Extension, Montana Tonopah, West End, Jim Butler, Halifax, McNamara, Tonopah Merger, Midway, and North Star.

The Tonopah-Belmont mine,[1] during its fiscal year, produced 181,370 tons of milling ore, which was treated in its cyanidation plant at the mine and yielded 40,591 ounces of gold and 3,714,862 ounces of silver. On account of the sluggish silver market only 2,068,763 ounces of silver were sold and the remainder, 1,646,099 ounces, was stored. The total value of the entire output in 1914 was $2,803,261.36. During 1914 the Tonopah-Belmont operated its 500-ton mill to full capacity. In the mine developments on the Favorite vein proved a remarkable deposit of high-grade ore, and many other veins were exploited with gratifying results. The cyanide mill of this company at Millers, Nev., operated continuously as a custom mill and was remodeled and improved. The following is from the company's annual report:

Previous to the outbreak of the European war the silver produced from your property was sold, at prices slightly higher than current New York quotations, to a banking institution in San Francisco, for shipment to the Orient against its bills of exchange. The war utterly demoralized foreign exchange as well as the silver market, with the result that after violent fluctuations the price of silver bullion per ounce dropped to approximately 49 cents and remained there during the last six months of the fiscal year, with a very limited demand. * * *

The ore reserves of the property, estimated as of March 1, 1915, consist of 226,921 tons of positive ore, 6,355 tons of probable ore, and of 61,808 tons of possible ore, or a total in reserve of 295,084 tons.

At the time of last year's estimate the Belmont vein ore body, on the fifteenth level, had not been reached, nor was there in evidence any geological condition which apparently affected the downward continuity of the ore body. The year's development at depth has, however, proven the ores of the Belmont vein to be cut off by the Mizpah fault at the bottom, and to terminate to the eastward, above the fifteenth level, against the glassy trachyte. Moreover, the ores of this vein, which almost entirely throughout the areas hitherto mined have been above the normal grade, have been proven by the year's development not to continue of high grade to the lower and eastern limits of the deposit, as was expected, but to diminish in tenor, generally, downward and to the east.

On the other hand, the development of the mine, apart from the Belmont vein, has been very encouraging. Most notable was the discovery and exploitation of the Western vein (unknown at the beginning of the period and which has produced over $300,000 during the year) and the development of the Favorite vein on the 900-foot level (which, from the 900-foot level and above, has produced over $200,000 during the latter half of the year), where an ore body of good width and excellent grade is being proven. The Shaft vein, the Occidental vein, the Favorite vein, the Mizpah fault "A" and "B" veins, the Lillie Belle vein, and the Western vein each show ore reserves as of March 1, 1915, which are greater than the last year's estimate minus the tonnages mined during the year. * * * There were 228,328 wet tons of crude ore hoisted, and from this 42,628 wet tons (or 18.67 per cent) were culled out as waste, and the remaining 185,700 wet tons, or 181,370 dry tons, were delivered to mill; 181,424 dry tons were milled, the additional 54 dry tons having been drawn from ore stocks. The average value per ton of the 181,370 dry tons mined was $16.747 (0.234 ounce gold and 22.34 ounces silver) as compared with the average per ton value of $21.034 (0.267 ounce gold and 26.32 ounces silver) of the previous year. The total operating costs were $7.268 per ton and the losses in mill tailings and in sales of concentrates were $1.274 per ton, the total costs and losses having been $8.542 per ton. The profit per ton, exclusive of miscellaneous earnings, was $8.205, and the percentage of profit from Tonopah operations was 48.99 per cent. * * *

The total operating costs at Tonopah were $7.268 per ton, a reduction from similar costs of the preceding year ($8.18 per ton) of $0.912 per ton.

During the fiscal year the direct mining cost per ton was $3.944, a reduction of $0.261 from the similar cost of the preceding year. The indirect mining cost was $0.369 per ton, a reduction of $0.125 per ton from the similar cost of

[1] Tonopah-Belmont Development Co. Twelfth Ann. Rept., for year ending Feb. 28, 1915.

the year previous. Total mining costs were $4.313, or $0.386 per ton less than the $4.699 of the preceding year. * * *

The direct milling cost for the year has been $2.156 per ton, a reduction from the direct milling cost ($2.560) of last year of $0.404 per ton. The indirect milling cost has been $0.408 per ton, which, as compared with the $0.489 of last year, shows a saving of $0.081 per ton. * * *

The table herewith shows the comparative concentrating results of the two years and the increase in the refractory content of concentrates made:

Concentrates made from ore milled at Tonopah-Belmont mill compared for years 1913 and 1914.

	1913	1914
Average gold content of ore milled ..... ounces..	0.2675	0.2236
Average silver content of ore milled ..... do....	26.331	22.3
Tons concentrates	794	1,211
Percentage by weight	.463	.668
Ounces gold per ton	3.167	2.368
Ounces silver per ton	611.08	446.05
Iron ..... per cent..	27	28.5
Sulphur ..... do....	24.4	28.3
Copper ..... do....	.39	.30
Lead ..... do....	1.16	.9
Zinc ..... do....	.8	.6

In this connection it will be remarked that for 1913 the ratio, by weight, of silver to gold was 101.6:1, while in 1914 this ratio was 95.4:1. In Belmont ores, at least (and aside from the very high grade ores), an increased proportion of gold seems to be indicated with the lower grade and more base ores. * * *

The Millers plant has been operated continuously throughout the fiscal year, with the exception of six days in November when the operations were stopped while changing over to a new process. During the year 44,692 dry tons of ore were treated, with a resulting profit, above all charges, of $24,344.43. The operation produced 1,031,745.20 ounces of silver and 12,468.927 ounces of gold.

Because of the unsatisfactory results in extractions and operating costs, the mill was reconstructed during the year and the process changed from slime filtration to the continuous counter-current decantation process.

During the first nine months of the year—with the filtration process—the mill treated 34,189 tons of ore. On this tonnage an average extraction of 87.45 per cent was made, at a total operating cost (direct and indirect) of $4.034 per ton. In January, 1915, with the new process in operation but as yet not properly tuned up, the extraction became 90.05 per cent and the total costs were $3.766 per ton. * * *

The Tonopah Mining Co.[1] during its fiscal year milled from mine and dump 143,432 dry tons of ore containing $5.08 in gold and 21.22 ounces of silver per ton. The gross value per ton of ore milled was $16.25 and the total cost per ton of mining, milling, freight, and marketing the mill products was $8.51, which, with $1.23 per ton charged to metal losses in milling and refining, leaves $6.51 profit per ton. Dividends were paid within the year amounting to $1,000,000. This dividend, with the one declared March 25, 1915, makes the total of $12,600,000 paid since April 22, 1905. The company in 1914 developed much new ground and found new ore. Its 500-ton cyanidation plant at Millers, originally a plant in which about half the ore was leached as sand and the other half was slimed, agitated, and filtered, was remodeled and by the addition of tube mills made into a 400-ton all-sliming mill. The counter-current system of continuous decantation is used and better extractions have been attained.

[1] Tonopah Mining Co. Ann. Rept. for year ending Feb. 28, 1915.

The West End mines[1] in 1914 produced 55,888 tons of ore, valued at $801,219.33, or an average value per ton of $14.33. This ore yielded bullion containing 10,681.41 ounces of gold and 1,050,157 ounces of silver, valued in all at $797,458.93. In addition, the West End mill treated 3,858 tons of amalgamation tailings, 564 tons of sand tailings, and ore from the Halifax, North Star, and Kernick mines aggregating 5,041 tons. The recoveries in the mill, according to the company's report, were as follows:

The percentage of values recovered from the total tonnage milled was 89.9 per cent. The cost of marketing was 2.1 per cent, giving a net extraction of 87.8 per cent. These results are lower than the results of 1913, which were, respectively, 91 per cent and 88.4 per cent. This is due entirely to the low extraction made upon the amalgamation tailings.

The results obtained upon the mine ore for the year were, respectively, 90.9 per cent and 88.7 per cent, gross and net extraction, exceeding net extraction of any previous year by 0.3 per cent.

The results obtained upon the amalgamation tailings were, respectively, 71.8 per cent and 70.6 per cent, gross and net extraction. This gross extraction checks closely the estimated extraction at the time of their purchase in 1911.

The results obtained upon the sand tailings were, respectively, 66⅔ per cent and 65.2 per cent, gross and net extraction. The tonnage being very small, it was literally lost in the mill and this gross extraction was set at the maximum figure obtainable in test work.

During the year there was an average of 25.4 stamps dropping continuously. The average daily tonnage was 179 tons, of which 153 tons was from the mine. This gives a daily stamp average of 7.05 tons. From January 1 to March 1, 20 stamps were in operation. At the end of that time the new unit of 10 stamps was put in operation, and 30 stamps were operated until November 15, when the number was cut to 20, due to the retimbering of the Halifax shaft cutting off that supply of custom ore.

The construction of the new 10-stamp addition, with its tube mill and all other additions necessary for the increased tonnage, was started on December 15, 1913, and it was put in operation on March 1, 1914, increasing the capacity of the mill to 205 tons of mine ore a day.

From the Montana and Midway properties[2] 63,551.43 tons of ore, having a gross value per ton of $8.793, were mined and milled at a total cost, exclusive of depreciation, of $7.784 per ton. Of this the Midway lease produced 8,121.74 tons, of a gross value per ton of $5.84. In addition, 203.12 tons of custom ore were treated in the mill, of which 20.75 tons, having a gross value per ton of $25.82, were produced by a lessee on the various mine dumps. The following extract is from the company's report:

Both mine and mill were operated continuously, except for holidays, stoppage of power, and general repairs, until November 15, 1914, on which date all operations, except mine development, were suspended on account of the grade of the ore and the price of silver, which declined from an average price of $0.5729 per ounce during the first six months of 1914 to an average price of $0.5027 per ounce during the period July 1 to October 31, 1914.

On August 3, 1914, your company and the Tonopah Midway Mining Co. entered into an agreement which allows your company to extract ore from and carry on general mining operations in the old workings of the eastern portion of the Midway Co.'s property for a period of three years. Under the terms of this agreement the Tonopah Midway Co. will receive 50 per cent of the profit on all ore mined and milled, after deducting the amount of metal losses in treatment, up to 10 per cent, and $8.50 per ton for operating expenses. * * *

Referring to the last annual report it will be seen that the gross value of the ore mined and milled during the past 16 months shows a decrease of $3.91 per ton, and the total cost per ton, exclusive of depreciation, shows a reduction of $0.767 per ton.

[1] West End Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[2] Montana-Tonopah Mines Co. Rept. for 16 months Sept. 1, 1913, to Dec. 31, 1914.

In its fiscal year 1914 there was mined on the Tonaph Extension[1] property 71,882 dry tons of ore, which was treated principally by cyanidation. The total content of the ore cyanided was 2,022,221 ounces of silver and 19,040.41 ounces of gold, or an average per ton of 28.13 ounces of silver and 0.26 ounce of gold. This was an increase of 13.26 ounces of silver and 0.108 ounce of gold per ton in 1914, as compared with 1913. Of the total bullion content, there were recovered and sold 1,790,032 ounces of silver and 17,584.77 ounces of gold, valued in all at $1,285,508, or an average recovery value per ton of $17.88. The cost per ton of handling the ore and bullion was as follows: Mining, $5.19; milling, $3.75; metal losses in milling, $2.08; express charges and refining bullion, $0.45, a total of $11.47 a ton. This total cost per ton subtracted from the total average value per ton, $19.96, leaves a profit per ton of $8.49. The capacity of the milling plant was increased from 150 tons to 250 tons of ore a day by adding 10 stamps, 2 tube mills with Dorr classifiers, 8 Wilfley concentrating tables, 2 Dorr thickeners, 5 agitators, and 9 zinc boxes.

Tybo district.—Ore was produced carrying principally silver but also a little copper and gold from the various old workings of the Silver Plume group.

Troy district.—The occurrence of the ore deposits in the Troy district is described by Hill,[2] who states that the Troy district, including Troy and Irwin Canyons, is at the south end of the Grant Range. The ore deposits occur in lime shales of probable Ordovician age, or in a stock of quartz monzonite which intrudes the shales and an overlying white quartzite that seems to be the Ordovician Eureka quartzite. In the shales the ore bodies are lenses of white quartz, with sphalerite, pyrite, galena, and possibly chalcopyrite, that carry silver and gold. Relatively narrow quartz veins in the quartz monzonite are sparingly mineralized, carrying pyrite with minor amounts of sphalerite and galena, which are said to carry gold and a little silver. No production was recorded from the district in 1914.

Union district.—From the treatment of old tailings from the old Berlin mine in a 40-ton cyanide plant gold and silver bullion was produced.

Willow Creek district.—Ore carrying gold and silver was shipped in 1914 to the smelter from the property of the Willow Creek Mining Co. The district is situated about 100 miles southeast of Ely and in the northwestern foothills of the Quinn Canyon range. Hill[2] states that the rocks of this region are of the same age as in the Troy district, but it is thought that some of the yellowish shales in the low hills may be Cambrian. A small stock of quartz monzonite intrudes the sediments, forming the low round hill north of the mouth of Willow Creek. The silver deposits carry sulpharsenides of silver and copper and arsenopyrite. They occur as tabular lenses along fissures in the shales. The gold occurs in white quartz veins that with depth seem to carry pyrite. The free gold of the surface ores is always associated with a green talc that is very conspicuous in the white quartz gangue.

[1] Tonopah Extension Mining Co. Ann. Rept. for year ending Mar. 31, 1915.
[2] Hill, J. M., unpublished notes on some Nevada mining districts.

ORMSBY COUNTY.

The output of 40 tons of ore made by four producers in 1914 is 1,017 tons less than was reported by the same number of producers in 1913. The total average value per ton of the ore increased from $6.92 in 1913 to $10.70 in 1914. Practically all of the value is for gold and silver. In addition to ore treated in gold and silver mills, there were 25 tons of old tailings estimated to have been treated that yielded gold and silver.

Carson River district.—Three operators reported the production of ore and bullion containing gold and silver, the principal part of which was recovered from old tailings on Carson River from the operations of the early Comstock mines.

Delaware district.—The 3-stamp mill in the district was operated a short time on ore taken from the Sad Sam group. A small quantity of gold bullion was recovered.

STOREY COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Storey County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	36	157,562	$853,564	729,972	1,870	4,037	$1,294,935
1914	36	103,406	434,387	278,599	1,094	.....	588,598
Decrease in 1914	.....	54,156	419,177	451,373	776	4,037	706,337

Thirty-six producers reported an output of 103,406 tons of ore, including old tailings re-treated. This output is 54,156 tons less than was reported by the same number of producers in 1913. The total average value per ton of the ore decreased from $8.22 in 1913 to $5.69 in 1914. Practically all this value is that of the gold and silver content. Most of the ore was of milling grade; it amounted to 101,322 tons and produced bullion containing $353,422 in gold and 242,477 ounces of silver, valued in all at $487,512, or an average value per ton of $4.80. This bullion output includes the gold and silver from the re-treatment of 350 tons of old tailings. In 1913 the bullion containing gold and silver was valued at $1,050,175, or an average value per ton of $6.91. There was also shipped from the county 559 tons of concentrates, containing $65,432 in gold, 24,310 ounces of silver, and 952 pounds of copper, valued in all at $79,002, or an average value per ton of $141.32. In 1913 the concentrates were valued at $228,039, or an average value per ton of $202.88. The ore of shipping grade was 111 tons, containing $15,533 in gold, 11,812 ounces of silver, and one small lot containing also some copper, valued in all at $22,084, or an average value per ton of $198.95. No placer production was reported.

Comstock district.—The total output of ore and old tailings in 1914 amounted to 103,406 tons, having a total value of $588,598. This is about half the value and about two-thirds the quantity produced in

1913 and reported by the same number of operators. In 1914 the larger part of the ore (101,322 tons) and 350 tons of old tailings were treated at gold and silver mills by the cyanidation process and produced bullion containing 17,096.75 ounces of gold and 242,477 ounces of silver, valued in all at $487,511, or an average value per ton of ore and tailings of $4.79. There were also some concentrates produced at these milling plants, which, with the concentrates produced at regular concentration mills, aggregated 559 tons, containing 3,165.28 ounces of gold, 24,310 ounces of silver, and 952 pounds of copper. Ore of shipping grade amounted to 111 tons, containing 751.44 ounces of gold, 11,812 ounces of silver, and 142 pounds of copper, valued in all at $22,084, or an average value per ton of $198.95. The principal producers were the Mexican, Monte Cristo, Ophir, Consolidated Virginia, Sierra Nevada, Silver Hill, and Jacket-Crown Point-Belcher mines.

Pumping operations in the Gold Hill mines by the Sturges interests, which control the Yellow Jacket, Crown Point, and Belcher mines, were worthy of note. The progress made in opening the properties is reviewed in a recent press article,[1] from which the following paragraphs are taken:

> Two Byron Jackson centrifugal pumps, similar to those installed on the 2,500-foot level of the C. & C. shaft, although of somewhat smaller capacity, were started in the old Belcher incline at the 1,400-foot level, which corresponds to the Sutro tunnel and the 1,600-foot level of the Virginia mines.
>
> Progress was made in cleaning out the old incline and in lowering the water. By April the old 1,600-foot level had been recovered and prospecting was carried on upon the 1,500 and 1,600 foot levels, low-grade ore being also taken, as formerly, from the vicinity of the upper workings, but not of a high enough grade to pay all the expenses.
>
> A promising body of ore has since been developed upon the 1,500 and 1,600 foot levels in the Belcher mine, mill samples of which run from $8 to $10 per ton. This ore is what is known as the "White Rock" or "Gold Vein" and lies to the west of the old bonanza stopes, where the values were both gold and silver in about equal proportions. In places this ore body is 60 to 80 feet wide. The assays vary considerably from place to place, and the length thus far worked has not been much greater than the width.
>
> The significance of the discovery, however, lies in the fact that this is the first time since 1886 that any work has been done below the 1,400-foot level. The Gold Hill mines were flooded in 1880, and after being pumped out were again flooded in 1881. The water rose slowly, and some work was done below the 1,400-foot level, mostly in taking out ore then in sight, up to 1886, when the Combination shaft in Virginia City stopped pumping. In that year the water in the Gold Hill mines rose rapidly, and after that up to the present year work was confined to reworking again and again the old ore bodies above the Sutro tunnel level.

WASHOE COUNTY.

Forty-five producers reported 5,295 tons of ore mined, 1,107 tons less than was reported by 47 producers in 1913. The total average value per ton decreased from $19.86 in 1913 to $14.60 in 1914 and the gold and silver value per ton of this ore from $15.23 to $11.93. The larger part of the ore was treated at concentration mills and produced 271 tons of lead concentrates, valued at $30,838, or an average value per ton of $113.79. In 1913 the output of concentrates was valued in all at $17,094, or an average value per ton of $122.10.

[1] Virginia City correspondence: Eng. and Min. Jour., Jan. 16, 1915, p. 155.

There were 2,185 tons treated in gold and silver mills, which yielded $33,205 in gold and 1,567 ounces of silver, valued in all at $34,071, or an average value per ton of $15.59. Ore of shipping grade amounted to 440 tons and contained $771 in gold, 10,071 ounces of silver, 34,694 pounds of copper, and 36,865 pounds of lead, valued in all at $12,392, or an average value per ton of $28.16. In 1913 the total value of the shipping ore was $51,451, or an average value per ton of $57.10. Placers operated by eight producers yielded $2,146 in gold and 38 ounces of silver in 1914.

Leadville district.—Ore produced from the Donnelly Mountain and the Tohoqua properties constitutes the principal part of the district output. There were shipped from the district 33 tons of lead ore carrying gold and silver and 2,670 tons were milled and produced lead concentrate containing silver and a little gold and copper. A little more than 600 tons was treated in a 5-stamp amalgamation mill and produced gold and silver bullion.

Peavine district.—There were 377 tons of ore reported by 13 producers. The larger part of the ore was of shipping grade, containing gold, silver, copper, and lead, and 110 tons produced gold and silver bullion from treatment at an amalgamation mill. The principal producers were the Hayes, Red Metal, and Emily May properties. The district and several of its mining properties are described by Hill[1] in a recent Survey bulletin.

Pyramid district.—This district, reached by the Fernley-Lassen branch of the Southern Pacific Railroad, is credited with the production of copper ore carrying silver and gold produced from two properties in 1914, the Franco American and the Nevada Pyramid.

Washoe or Jumbo district.—The Last Chance claim produced a small quantity of ore which contained gold and a little silver recovered by amalgamation.

White Horse district.—Most of the ore produced in this district (1,418 tons) was treated in amalgamation mills and yielded 1,340.05 ounces of gold and 550 ounces of silver. There were also 6 tons of shipping ore containing gold and silver. The total output, including the bullion produced from some surface mining, was valued at $30,104. Most of the ore was treated at the Slipp mill, which is a custom plant equipped with two 3½-foot Huntington mills using the amalgamation process. Among the producers were the Green Hill, Renegade, Ruth R., and Cabin properties.

WHITE PINE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in White Pine County, Nev., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	26	3,449,333	$432,482	194,716	71,974,116	747,331	$11,738,962
1914	31	2,751,473	[a] 364,912	[a] 105,281	51,176,830	915,602	7,265,360
Increase (+) or decrease (−) in 1914		−697,860	−67,570	−89,435	−20,797,286	+168,271	−4,473,602

[a] Includes placer production.

[1] Hill, J. M., Some mining districts in northeastern California and northwestern Nevada: U. S. Geol. Survey Bull. 594, pp. 184–196, 1915.

The bulk of the ore produced in White Pine County is from one mining property and the remainder is from 25 smaller producing mines. In 1914 there were 2,751,473 tons mined, 697,860 tons less than were mined in 1913. The total average value per ton of the ore decreased from $3.40 in 1913 to $2.64 in 1914, and the gold and silver value per ton in this ore decreased from 16 cents to 15 cents. From 2,735,415 tons of ore concentrated 445,223 tons of concentrates were produced, containing $348,180 in gold, 52,005 ounces of silver, and 50,225,352 pounds of copper, valued in all at $7,056,911, or an average value per ton of $15.85. The output of concentrates in 1913 amounted to $11,300,567, or an average value per ton of $23.57. Crude ore directly smelted amounted to 15,661 tons and contained $12,530 in gold, 45,614 ounces of silver, 913,539 pounds of copper, and 837,319 pounds of lead, valued in all at $191,911, or an average value per ton of $12.25. In 1913 the smelting ore was valued at $436,314, or an average value per ton of $14.53. Five placer producers reported an output of $2,537 in gold and 20 ounces of silver.

Aurum district.—No production was recorded in 1914. The mines on the east side of the north end of the Schell Creek Range, near Muncy, Silver, and Siegle creeks, and Schellbourne are included in this district. According to Hill[1] the range is composed of Cambrian quartzites and limestones which strike north and dip west. The sediments are cut by a series of faults trending north and east and have been intruded by stocks and dikes of granite porphyry. The ore deposits are of three types. Lead and silver bearing replacements occur along eastward-trending fissures in the limestone. The most common ore minerals are argentiferous cerusite, but some zinc carbonate, galena, and anglesite are usually found. A peculiar class of this type of deposit, represented by the Gold Crown, the Siegle, and the Lucky Deposit ore bodies, carries an abundance of soft, black argentiferous manganese oxide in the upper part of the deposit. Some lead is present in this ore, but silver is said to be abundant and seems to be carried as a chloride. North of Muncy Creek the intrusion of two stocks of granite porphyry has resulted in the formation of some small masses of garnet rock, in which pyrite and chalcopyrite occur. The Signal mine in Silver Creek is peculiar in that pyrrhotite and chalcopyrite carrying gold have been deposited apparently as a replacement of granite porphyry and the calcareous matrix of an impure quartzite.

Bald Mountain district.—This region, embracing a small area around Joy, is about 56 miles by road northeast of Eureka and 80 miles south of Halleck, on the Southern Pacific Railroad. Hill[1] states that the formations are lime shales, limestones, and quartzites that are believed to be of Upper Cambrian and Ordovician ages and have been intruded by a small stock of quartz monzonite, which has produced some small belts of lime silicate minerals. Antimonial silver-lead ores are found in fissure replacements at some distance from the igneous rock, and gold-bearing copper ores occur in the fissures near the stock. Small white quartz veins, carrying slightly cupriferous pyrite, with stibnite and marcasite that are said to carry gold, have been opened in the granitic rock.

[1] Hill, J. M., unpublished notes on some Nevada mining districts.

Cherry Creek (*Egan Canyon*) *district.*—The larger part of the ore produced in 1914 came from the Adelaide group, some from the Joanna and from six other properties, the total amounting to 300 tons containing $7,497 in gold, 20,662 ounces of silver, 2,263 pounds of copper, and 54,132 pounds of lead, valued in all at $21,336, or an average value per ton of $71.12. The larger part of the ore (222 tons), containing copper and lead, was shipped directly to smelters, and 78 tons were treated in a gold and silver mill and produced bullion and concentrate. The mines of the district are all on the east side of the Egan Range, about 90 miles south of Cobre, on the Southern Pacific Railroad, and 50 miles north of Ely, the seat of White Pine County. According to Hill[1] the veins are found in quartzites, slates, and limestones of Cambrian age, which in this locality dip 30°–35° W., and strike N. 10°–30° E. They have been intruded by dikes of quartz monzonite porphyry near the mouths of both Egan and Cherry canyons. The more important veins consist of galena, sphalerite, and pyrite, carried in a white quartz gangue. They are largest and productive only in quartzites, and tend to finger out in argillaceous shales. The veins have been crushed by movement since the deposition of the ores and have been enriched by the deposition of sulphides and sulpharsenides by downward moving waters. A less important series of gold-silver veins consist of white quartz that shows minor quantities of pyrite and less galena. It is thought that these veins may grade into the gold-silver-lead veins. The mineralization of these veins probably took place shortly after the consolidation of the quartz monzonite porphyry.

Duck Creek district.—Six deep-mine operators reported 118 tons of shipping ore, containing $74 in gold, 1,063 ounces of silver, 4,331 pounds of copper, and 130,540 pounds of lead, valued in all at $6,329, or an average value per ton of $53.64. The principal producers were the Ely Amalgamated and the Cuba properties. This district covers a northward-trending ridge west of Schell Creek Range that is separated from the main mountains by Duck Creek valley. Most of the mines are within 3 miles of the smelter town of McGill, 13 miles northeast of Ely. According to Hill,[1] the ridge is composed of massive bedded limestones, thought to be of Ordovician age, that strike north and dip west. Igneous rocks are not important in this vicinity, though a small stock of granite is seen just south of the mouth of Duck Creek and narrow dikes of very much altered rock, that presumably was granite porphyry, are found on the Ely Gibraltar ground. The ores are most valuable for lead, but also carry a little silver and some copper and zinc. They occur in bedded and fissure replacement bodies, none of which appear to be large. Galena occurs in the surface ores and is only slightly altered to anglesite and cerusite.

Granite (*Steptoe*) *district.*—Ore amalgamated in the 5-stamp mill on the Royal No. 1 property produced a small quantity of gold bullion containing silver. The district is situated on the east side of the Egan range, about 23 miles north of Ely, and according to Hill,[1] covers an area of Cambrian quartzites, shales, and limestones which have been intruded by a large stock of granite and some dikes of granite porphyry. Narrow quartz veins, carrying gold, occur in the

[1] Hill, J. M., unpublished notes on some Nevada mining districts.

quartzite and small fissure replacement deposits, whose chief value is in lead, are found in the overlying limestone.

Hunter district.—Old slag and a small quantity of crude ore shipped to the smelters yielded lead, copper, silver, and a little gold, all of which was from the Hunter group, operated by the Vulcan Mining Co. The mines are situated on the west side of Egan range, 24 miles south-southwest of Cherry Creek. In this vicinity, according to Hill,[1] occurs the Devonian Nevada limestone with a prevailing northerly strike and low westerly dip which has been intruded by granite porphyry, along which there is no contact metamorphism. Faulting has taken place along the contacts of the intrusive masses, producing rather large bodies of brecciated limestones. The oxidized lead and copper ores occur with white calcite as irregular replacements of the fault breccias. The ores carry about as many ounces of silver as there are units of lead, but an increase of the copper content seems to raise the silver value of the ore. In the early days the ores were smelted at the mine, but all ore mined in the last few years has been shipped.

Kern district.—No production was recorded for this district in 1914. The region includes the Kern Mountains and the eastern part of the Antelope Hills, and is situated in the northeastern part of White Pine County. According to Hill,[1] the central part of this mountain mass is a muscovite-biotite granite that is intrusive into quartzites, slates, and limestones of supposed Cambrian age. Quartz veins in the granite carry enargite, galena, and sphalerite that is said to contain both silver and gold; other quartz veins, that may be related to the pegmatitic phase of the granite, contain a little hübnerite. In the sedimentary rocks surrounding the granite, there are a few prospects on bodies of oxidized lead-silver or copper-silver ores. This region is at least 65 miles from railroad transportation, and little work has been done here.

Osceola district.—A small quantity of ore, containing gold and silver, is said to have been produced from the Serpent claim, taken out in doing assessment work.

Pinto district.—Ore shipped from the Washington property in 1914 contained lead, silver, and a little copper.

Robinson (Ely) district.—The total production of the district from 1908 to the end of 1914 has been 16,474,025 tons of ore, containing $2,580,647 in gold, 521,517 ounces of silver, 393,606,696 pounds of copper, and 745,440 pounds of lead, valued in all at $57,883,380.

Ore sold or treated in Robinson district, White Pine County, Nev., total content of gold, silver, copper, and lead, and number of producers, 1908–1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1908	6	430,031	$94,443	30,381	14,797,295	2,381	$2,063,888
1909	10	1,671,225	370,569	79,487	57,481,515	524,512	7,907,053
1910	10	2,375,032	423,225	108,000	63,914,197	180,407	8,606,586
1911	4	2,776,930	435,287	104,107	67,033,547	10,216	8,870,118
1912	5	3,023,082	474,436	78,020	67,373,510	12,168	11,639,595
1913	3	3,447,812	430,347	68,793	71,916,711	15,756	11,619,681
1914	2	2,749,913	352,340	52,729	51,089,921	.....	7,176,459
Decrease in 1914	.....	697,899	78,007	16,064	20,826,791	15,756	4,443,222

[1] Hill, J. M., unpublished notes on some Nevada mining districts.

In 1914 the most important producers were the Nevada Consolidated and the Consolidated Copper Mines Co., controlling the Giroux and some other properties.

The Nevada Consolidated property[1] produced by steam-shovel operations a large output of porphyry copper ore.

The following is from the company's annual published report:

Mining has been carried out during 1914 by underground methods at the Veteran and by steam shoveling at the Eureka, Hecla, and Liberty pits.

In previous years the major portion of the ore was taken from the Eureka pit, but, as will be seen from the following statement, such was not the case in 1914, the Liberty and Hecla far exceeding the tonnage taken from the Eureka, though the grades were the same.

Owing to the low price of copper * * * it was decided to close down the Veteran mine temporarily, and this was done as of November 1.

Due to financial conditions and the decreased demand for copper, the production was greatly reduced in the latter part of 1914, beginning with August.

The following table shows the ore mined and shipped to the concentrator during 1913 and 1914:

Operations of Nevada Consolidated copper mine, 1913–14.

	1913		1914	
	Short tons.	Percentage of copper.	Short tons.	Percentage of copper.
Eureka pit	1,543,456	1.511	578,981	1.405
Liberty-Hecla pits	1,345,933		1,934,260	1.405
Veteran	258,896	2.588	123,324	3.063
Total	3,148,285	1.597	2,636,565	1.483

Siliceous carbonate ore, amounting to 14,498 tons and averaging 2.51 per cent copper, was mined, all of which was crushed and delivered to the smelter. * * *

The direct mining cost by steam shovel for the Eureka, Hecla, and Liberty pits has been 15.17 cents, showing a considerable reduction from 1913 [when it] was 17.75 cents. This figure includes charges of all kinds, such as labor, supplies, repairs, management, taxes, and a proper proportion of New York and Nevada overhead charges.

Owing to a higher percentage of iron sulphide from the shovel pits, the ratio of concentration was even less favorable than in 1913, being 6.94 in the latter year and 6.05 in 1914.

Operations of Nevada Consolidated mill in 1914.

Tons of ore treated (dry)	2,640,294
Average copper assay—per cent	1.483
Percentage of extraction	68.48
Ratio of concentration	6.05
Assay value, gold—ounces	.013
Assay value, silver—do	.031
Percentage extraction, gold	46.75
Percentage extraction, silver	60.76
Average gold and silver recovered per ton in cents	13.45
Average copper in concentrates	6.145

Owing to curtailment in the latter half of the year, the tonnage for 1914 was less than for the preceding year, amounting to 2,640,294 dry tons, averaging 1.483 per cent, as against 1.599 per cent in 1913. Average copper in concentrates was 6.145 per cent, as against 7.61 per cent in the former year. * * *

[1] Nevada Consolidated Copper Co. Eighth Ann. Rept., for year ending Dec. 31, 1914.

The yield for the year 1914 from all ore mined and treated and from siliceous carbonate ore delivered to the smelter was 49,244,056 pounds of copper.

The average cost per pound of copper was 10.16 cents, and deducting miscellaneous earnings this is reduced to 9.82 cents. Costs include all possible charges. * * *

The profit and loss statement for the year shows a net profit of $1,763,020.58, a decrease from the earnings of last year of almost 50 per cent. During the year three dividends, amounting to $2,249,389.11, were declared and paid; this brings the total dividend disbursements to December 31, 1914, to $14,977,250.81, and there remains as surplus earnings $2,290,626.15. In addition to these dividend disbursements from profits there has been returned to stockholders from surplus $1,999,457 in the shape of extra dividends, which, as has been explained in previous reports, has been charged against surplus account. No such disbursement, however, was made during the year 1914 on account of decreased output and the cash situation of the company.

Taylor district.—This district is situated 16 miles southeast of Ely and 2 miles east of the Ely-Osceola stage road in low hills on the west side of the Schell Creek range. No production was recorded in 1914. According to Hill,[1] limestones which are possibly of Silurian age dip east at low angles in this vicinity. They are cut by northward-trending normal faults, which dip east at high angles. The silver ores occur as a replacement of a particular bed of brownish-colored limestone that has been silicified in the ore zone. The original ore minerals seem to have been galena, enargite, and sphalerite. The ore bed is 70 feet thick and has two higher grade beds of ore near the center of the upper and lower halves that are separated by 4 to 10 feet of barren limestone. Cerusite and malachite, both of which are silver bearing, are the principal minerals of the oxidized zone. Post mineral faulting has dislocated the replaced bed, though probably some of the movement along the same planes occurred prior to the ore formation.

Ward district.—The lead-silver-zinc-copper deposits of the old Ward district, 15 miles south of Ely on the east side of the Egan Range, occur, according to Hill,[1] in Pennsylvanian limestones that have been intruded in a most intricate manner by quartz monzonite porphyry. The ore bodies occur along the contacts of the intrusive and limestone, and the ore minerals are found in both rocks in replacement deposits and veins. The ores mined in the early days, to a depth of about 175 feet, were lead carbonates carrying a considerable quantity of silver. The original ores of the Defiance body seem to consist largely of silicified limestone carrying abundant pyrite and some galena and sphalerite. In the Good Luck and the Paymaster bodies the original ores, as evidenced by the lower workings, consist of sphalerite, galena, pyrite, and chalcopyrite, that occur both in the limestone and in the quartz monzonite porphyry. There has been some sulphide enrichment of the ores in this district, though the rich silver sulpharsenides and antimonial minerals are not abundant. No production was recorded in 1914.

White Pine (Hamilton) district.—Five producers reported the output of 736 tons of ore, containing $1,520 in gold, 22,301 ounces of silver, 40,184 pounds of copper, and 572,311 pounds of lead, valued in all at $41,517, or an average value per ton of $56.41. The principal producer was the Grand Prize group, which produced sulphide lead ore. This property is opened by a tunnel 200 feet long, in which

[1] Hill, J. M., unpublished notes on some Nevada mining districts.

a winze has been sunk 120 feet deep. There was no new development in 1914. The ore is all hand sorted and produces a $50 grade for shipment to the smelter. The tailings from this sorted ore are reserved for future jig treatment. The Jennie A. claim produced some lead carbonates carrying silver and a little gold. The property is opened by an incline shaft 330 feet deep. All of the ore shipped was of smelting grade and jiggings from some dump material were mixed with the shipments. Lead sulphide ore carrying silver and a little gold and copper was shipped from the Young Treasure claim. The main tunnel on the property was extended over 100 feet and crosscuts aggregating 200 feet were run from it during 1914.

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GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH IN 1914.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

The mine production of gold, silver, copper, lead, and zinc in Utah in 1914—a small placer output included—was valued at $37,151,593, a decrease of $7,706,617 compared with $44,858,210 in 1913. There were 211 producers, including 7 placers, of ore and bullion, as against 210 lode producers and 7 placers in 1913. More than 54 per cent ($20,220,522) of the total value was that of copper, a decrease of $4,803,602 from the value of the copper output in 1913. Gold decreased $299,882 in value of output from $3,565,229 in 1913 to $3,265,347 in 1914, and the value of the silver decreased $1,734,571, from $7,903,240 to $6,168,669. The quantity of lead increased, but its value, $6,681,602, was $627,977 less than in 1913. The value of zinc (calculated as spelter) decreased from $1,056,038 to $815,453 in 1914, or $240,585. The placer output of gold decreased from $1,920 to $1,231 in 1914.

The following table shows the mine production of metals in 1913 and 1914, with increase or decrease in 1914:

Mine production of gold, silver, copper, lead, and zinc in Utah in 1913 and 1914, with increase or decrease in 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	217	10,202,566	$3,565,229	13,084,835	161,445,962	166,126,790	18,857,827	$44,858,210
1914	211	8,544,014	3,265,347	11,154,916	152,034,002	171,323,137	15,989,267	37,151,593
Increase (+) or decrease (−) in 1914		−1,658,552	−299,882	−1,929,919	−9,411,960	+5,196,347	−2,868,560	−7,706,617

[a] Includes small placer production.

From 1864 to 1914, inclusive, the ore deposits of Utah have produced metals valued at more than $672,000,000. This production, beginning with 1864, is given by periods in the following table and also by years in a corresponding table in the report for the year 1913.[1]

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 366, 1914.

Production of metals in the State of Utah, 1864–1914, by periods.

Period.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1864–1880	$3,118,096	33,873,227	5,754,194	350,713,000	.....	$64,155,452
1881–1890	2,677,184	56,137,249	11,830,773	556,316,000	.....	87,101,029
1891–1900	17,739,206	75,346,301	47,349,628	743,792,000	.....	106,606,912
1901–1910	43,252,210	111,068,934	624,858,979	1,130,541,875	47,051,438	252,820,473
1911	4,696,998	12,473,787	146,960,827	136,496,750	17,840,261	36,837,457
1912	4,265,851	13,835,903	137,307,485	140,311,135	17,067,177	42,922,302
1913	3,565,229	13,084,835	161,445,962	166,126,790	18,857,827	44,858,210
1914	3,265,347	11,154,916	152,034,002	171,323,137	15,989,267	37,151,593
Total	82,580,121	326,975,139	1,287,541,850	3,395,620,687	116,805,970	672,453,428

The total value, $672,453,428, given in the table, is obtained by estimating the output of each metal at the average commercial price for each calendar year; it includes $82,580,121 in gold, $245,718,725 in silver, $187,389,233 in copper, $150,061,673 in lead, and $6,703,676 in zinc. Dividends paid by 16 producers and amounting to $7,431,017 were reported in 1914. This amount added to the sum of the dividends known to have been paid by 82 producers in previous years gives a total of dividends paid of $118,570,710 at the end of the year 1914.

PRODUCTION OF ORE IN 1914.

There were 8,544,014 tons of ore sold or treated in Utah in 1914, which had a metal output (placer production included) valued at $37,151,593, a decrease of 1,658,552 tons in quantity and of $7,706,617 in value, compared with the production of 1913. The average total value per ton was $4.35 in 1914, against $4.39 in 1913, and the gold and silver value per ton declined from $1.12 to $1.10. In addition to the large output of low-grade "porphyry" copper ore, considerable old mine dump material was shipped to the smelters from the Tintic district.

The output of dry or siliceous ores decreased from 238,901 tons in 1913 to 149,902 tons in 1914. This classification includes 1,987 tons of low-grade siliceous gold ores, averaging $8.91 in gold and 3.36 ounces of silver a ton. Gold and silver mixed ores, dry or siliceous in character, aggregated 77,653 tons and averaged per ton $3.17 in gold, 6.48 ounces of silver, 22.89 pounds of copper, and 0.46 pound of lead. The siliceous silver ores mined in 1914 by 20 producers amounted to 69,379 tons and averaged per ton $1.64 in gold, 11.47 ounces of silver, 3.21 pounds of copper, and 11.01 pounds of lead, against 73,294 tons produced by 21 producers in 1913, which averaged $1.18 in gold, 16.06 ounces of silver, 1.77 pounds of copper, and 7.90 pounds of lead. The Ontario mine, in the Park City region, was the largest producer of silver ore, the Tintic district taking second place, with 8 producers. Only 883 tons of iron manganese ore was produced, against 15,034 tons in 1913. This ore came in 1914 from one mine in Beaver County.

The copper ore mined by 45 producers amounted to 7,578,220 tons and contained 27 cents in gold and 0.23 ounce of silver per ton and 0.94 per cent of copper, and averaged $2.90 a ton in value. Comparison with ore of similar character produced in 1913 shows that

the gold content increased slightly and the copper content increased more than 2 pounds a ton. The silver content decreased slightly. Of the copper ore mined, the larger part, or 7,106,544 tons, was from the low-grade "porphyry" deposits at Bingham and Newhouse. This ore produced 360,559 tons of copper concentrates, which were smelted. There were 471,626 tons of copper ore smelted directly, of which 408,598 tons were sulphide ore, assaying $2.40 in gold and 1.80 ounces of silver per ton, and 1.78 per cent of copper, and valued in all per ton at $8.13; and 63,028 tons were oxidized ore, assaying $4.79 in gold and 10.02 ounces of silver per ton, and 2.13 per cent of copper, valued in all per ton at $16.

The output of lead ores of smelting grade decreased from 357,196 tons in 1913 to 337,233 tons in 1914. There was an increase in the production of the oxidized lead ores, consisting chiefly of carbonates and some oxidized iron ores. In 1914 the oxidized lead ores smelted amounted to 178,622 tons, assaying $1.91 in gold and 23.91 ounces of silver per ton and 0.52 per cent of copper and 15.05 per cent of lead, and having an average total value per ton of $28.26. The sulphide lead ores smelted decreased in quantity in 1914 to 158,611 tons, averaging $1.21 in gold and 12.78 ounces of silver per ton and 0.78 per cent of copper and 18.81 per cent of lead, and valued in all per ton at $25.03.

Production of zinc ores of shipping grade decreased from 15,300 tons in 1913 to 4,670 tons in 1914. A little more than half of the zinc ore (2,402 tons) was sulphide and contained an average of 33.77 per cent of zinc. The oxidized or mixed carbonate and silicate zinc ores aggregated 2,268 tons and contained an average of 30.03 per cent of zinc. Of the lead-zinc sulphide ore, which predominated, there were shipped to the smelters 6,083 tons, containing an average of 2.52 ounces of silver per ton and 8.04 per cent of lead and 32.37 per cent of zinc. The oxidized ores of this class amounted to 373 tons and averaged 17 cents in gold and 2.32 ounces of silver per ton and 11.07 per cent of lead and 24.19 per cent of zinc.

Production of copper-lead ores decreased from 2,740 tons to 1,077 tons, all of which were oxidized or carbonate copper-lead ores and averaged $1.25 in gold and 31.51 ounces of silver per ton and 4.18 per cent of copper and 10.88 per cent of lead and $38.30 in total value per ton.

Ores of concentrating grade, containing principally lead, amounted to 260,223 tons, from which were recovered 74,445 tons of lead concentrates and 38 tons of zinc concentrates. From the ores, amounting to 153,102 tons, containing both lead and zinc, 53,513 tons of lead concentrates and 11,831 tons of zinc concentrates were recovered. The lead concentrates produced from lead ores and lead-zinc ores aggregated 127,958 tons and averaged $2.54 in gold and 13.25 ounces of silver per ton, and 21.55 per cent of lead and a trace of copper, and were valued in all per ton at $29.34; and the zinc concentrates from the lead and lead-zinc ores aggregated 11,869 tons and averaged 13 cents in gold and 4.97 ounces of silver per ton, and 1.10 per cent of lead and 37.43 per cent of zinc, with a trace of copper, and were valued in all per ton at $41.96. Concentrates of all kinds produced in Utah in 1914 including those heretofore mentioned aggregated 500,458 tons and contained 32.76 per cent of the gold, against

22.3 per cent in 1913; nearly 19 per cent of the silver, against 20.1 per cent in 1913; 84.4 per cent of the copper, against 80 per cent; 32.34 per cent of the lead, against 31.9 per cent; and more than 55 per cent of the zinc, against 48.4 per cent in 1913. In 1914 the recoverable metal content of the concentrates was valued at $21,922,428, or a total average value per ton of $43.80, as against a total value in 1913 of $25,274,244, or a total average value per ton of $48.06.

Crude ore of all kinds shipped directly to the smelters represented 10.65 per cent of the total output and produced 66.6 per cent of the gold in 1914, as against 69.8 per cent in 1913; 78.2 per cent of the silver, against 77.3 per cent; 15.5 per cent of the copper, against 19.8 per cent; 67.4 per cent of the lead, against 66.3 per cent; and 44.4 per cent of the zinc, against 51.5 per cent in 1913. In 1914 the total value of the crude ore shipped to smelters was $15,004,591, or an average value per ton of $16.48, as against a total value in 1913 of $18,949,742, or an average value per ton of $16.25.

At mills using cyanidation and amalgamation, 0.47 per cent of the total gold and 0.10 per cent of the silver was recovered from 2,166 tons of ore and 15,500 tons of old tailings. The gold and silver were valued at $21,706, or an average per ton of $1.23. In 1913 the recovery of gold and silver from ores given similar treatment was valued at $308,024, or an average per ton of $3.88.

Output of ore and production of metals in Utah in 1914 by kinds of ore.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Value.*	*Fine ounces*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	7	.....	$1,231	9	.....	.....	.....
Dry or siliceous	45	149,902	377,766	1,317,364	2,020,504	814,047	.....
Copper	45	7,578,220	2,024,916	1,726,230	142,988,221	2,179	.....
Lead	125	600,481	684,128	7,350,213	6,147,939	146,373,700	16,341
Zinc	14	4,670	.....	.....	.....	.....	2,984,486
Copper-lead	20	1,183	1,616	37,216	101,794	272,376	.....
Lead-zinc	15	209,558	175,690	723,884	775,544	23,860,835	12,988,440
Total	.....	8,544,014	3,265,347	11,154,916	152,034,002	171,323,137	15,989,267

Subdivision, by kinds, of ore sold or treated in Utah in 1914, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	1,287	60,477	13,690	2,402	.....	16,665	94,521
Boxelder	15	924	58	.....	.....	.....	997
Cache	.....	.....	10	.....	.....	.....	10
Grand	.....	6	.....	.....	.....	.....	6
Iron	6	.....	.....	.....	.....	.....	6
Juab	103,184	61,416	123,552	466	180	88	288,886
Morgan	.....	.....	13	.....	.....	.....	13
Piute	1,348	21	88	.....	.....	.....	1,457
Salt Lake	4,287	7,455,092	260,611	17	833	92,511	7,813,351
Summit	39,568	.....	91,564	.....	.....	50,860	181,992
Tooele	152	268	94,867	1,163	143	.....	96,593
Utah	20	.....	10,179	622	27	339	11,187
Wasatch	.....	16	5,849	.....	.....	49,095	54,960
Washington	35	.....	.....	.....	.....	.....	35
Total	[a] 149,902	7,578,220	600,481	4,670	1,183	209,558	8,544,014
Value per ton in gold and silver	$7.38	$0.39	$7.91	.....	$18.76	$2.75	$1.10

[a] Includes 1,987 tons of gold ore, 77,653 tons of gold and silver ore, 69,379 tons of silver ore, and 883 tons of iron ore.

GOLD.

The mine production of gold reported from Utah in 1914 was valued at $3,265,347, a decrease of $299,882, compared with 1913. The largest part of the gold was contained in ores produced in Salt Lake County and amounted to $2,159,500, against $1,777,214 in 1913. Juab County ranked next with $933,072, against $1,385,070 in 1913. Bingham district produced $2,151,520 and Tintic district $953,790; in 1913 these productions were, respectively, $1,774,815 and $1,412,462. Tooele County mines were credited with only $16,468, against $202,664 in 1913. Placer gold was produced in Garfield, Grand, and Uinta counties and amounted in value to $1,231, against $1,920 in 1913. Ores treated in mills equipped for amalgamation produced $2,196 in gold in 1914 from 553 tons of ore mined in Beaver, Boxelder, Juab, and Washington counties. Cyanidation was carried on in Beaver, Juab, Piute, Salt Lake, Tooele, and Utah counties and produced $13,087 in gold from 1,613 tons of ore and 15,500 tons of old tailings. The gold extracted by amalgamation averaged $3.97 a ton of ore treated, as against $6.45 a ton of ore treated in 1913; and by cyanidation $0.71, as against $3.52. Concentrates of copper, lead, zinc, and a small quantity of siliceous concentrate contained $1,069,662 in gold, against $797,009 in 1913. Copper concentrates contained the largest quantity of gold, or 35,863.89 ounces, against 29,699.38 ounces in 1913 and 36,882.93 ounces in 1912; the lead concentrates contained 15,739.60 ounces, against 8,606.73 ounces in 1913; and the zinc concentrates 74.39 ounces, against 193.66 ounces in 1913.

Source of mine production of gold in Utah, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	.....	145.71	245.55	447.61	.....	163.31	1,002.18
Boxelder	.....	15.53	.14	4.16	.....	.....	19.83
Garfield	13.50	.....	.....	.....	.....	.....	13.50
Grand	1.64	.....	2.08	.....	.....	.....	3.72
Iron	.....	2.18	.....	.....	.....	.....	2.18
Juab	.....	17,290.67	14,565.61	13,270.79	6.37	3.92	45,137.36
Piute	.....	357.98	7.35	16.16	.....	.....	381.49
Salt Lake	.....	274.26	83,127.48	13,309.02	26.32	7,728.73	104,465.81
Summit	.....	75.08	.....	3,963.22	.....	25.25	4,063.55
Tooele	.....	78.71	7.11	703.27	7.55	.....	796.64
Uinta	44.41	.....	.....	.....	.....	.....	44.41
Utah	.....	11.09	.....	1,220.77	37.93	3.05	1,272.84
Wasatch	.....	.....	.....	159.69	.....	574.74	734.43
Washington	.....	23.22	.....	.....	.....	.....	23.22
Total	59.55	[a] 18,274.43	97,955.32	33,094.69	78.17	8,499.00	157,961.16

[a] Includes 856.32 ounces from gold ore, 11,901.80 ounces from gold and silver ore, 5,508.11 ounces from silver ore, and 8.20 ounces from iron ore.

SILVER.

The mine production of silver in Utah in 1914, including a small placer output, was 11,154,916 ounces, valued at $6,168,669, a decrease of 1,929,919 ounces in quantity and of $1,734,571 in value. The largest production came from Juab County, credited with 4,444,996 ounces, against 5,600,617 ounces in 1913. Salt Lake County had the next largest output, 2,629,153 ounces in 1914, against 2,504,021 ounces in

1913. In Salt Lake County the Bingham district produced nine-tenths of the county total. Concentrates produced at milling plants yielded 2,114,993 ounces of silver, against 2,637,873 ounces in 1913. The copper ores milled produced 358,486 ounces, against 324,586 ounces in 1913 and 347,867 ounces in 1912. Lead concentrates from low-grade lead ore contained 1,695,790 ounces, or an average per ton of 13.25 ounces, against 2,177,101 ounces, or an average per ton of 16.82 ounces, in 1913; zinc concentrates contained 4.97 ounces per ton, against 9.76 ounces per ton in 1913. The silver content of bullion produced from ores and tailings treated by amalgamation was 78 ounces, against 312 ounces in 1913, and that produced by cyanidation was 11,536 ounces, against 60,720 ounces in 1913. At Park City the leaching process in use on the Ontario ore resulted in the shipment of several hundred thousand ounces of silver. Experiments were made on the American Flag ores with the leaching process, for which the Grasselli mill was purchased and remodeled. Results were not reported as to the success of these experiments or of the experiments by the Knight-Christensen[1] process in the Tintic district.

Source of mine production of silver in Utah, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver		14,876	12,080	201,022		60,843	288,821
Boxelder		1,990	342	927			3,259
Cache				39			39
Garfield	2						2
Grand			171				171
Iron		2,200					2,200
Juab		992,819	621,876	2,826,250	2,875	1,176	4,444,996
Morgan				5			5
Piute		9,252	651	1,773			11,676
Salt Lake		4,839	1,088,935	1,223,543	23,677	288,159	2,629,153
Summit		291,117		2,108,355		19,092	2,418,564
Tooele		254	2,145	542,242	10,397		555,038
Uinta	7						7
Utah		8		263,392	267	865	264,532
Wasatch			30	182,665		353,749	536,444
Washington		9					9
Total	9	[a] 1,317,364	1,726,230	7,350,213	37,216	723,884	11,154,916

[a] Includes 6,671 ounces from gold ore, 503,487 ounces from gold and silver ore, 795,646 ounces from silver ore, and 11,560 ounces from iron ore.

COPPER.

In 1914 the mine production of copper in Utah was 152,034,002 pounds, valued at $20,220,522, a decrease of 9,411,960 pounds in quantity and of $4,803,602 in value. Bingham, or the West Mountain district produced 141,924,811 pounds of copper in 1914 against 144,920,494 pounds in 1913, 116,621,793 pounds in 1912, and 129,995,865 pounds in 1911. The Tintic district produced 5,290,471 pounds in 1914 against 9,261,867 pounds in 1913, a decrease of 3,971,396 pounds. The Park City region produced 1,559,953 pounds of copper against 1,794,170 pounds in 1913; Beaver County, 1,511,888 pounds against 3,137,234 pounds in 1913; and Tooele County, 1,295,288 pounds against 1,522,596 pounds in 1913. Concentrates of all

[1] Knight-Christensen mill destroyed by fire Apr. 6, 1915. Construction started again, using equipment from the Ontario leaching plant at Park City, which was entirely dismantled.

kinds produced at Utah milling plants contained 128,339,987 pounds of copper against 129,253,116 pounds in 1913. Copper concentrates contained 125,778,515 pounds against 126,364,491 pounds in 1913; lead concentrates contained 2,558,128 pounds of copper against 2,820,409 pounds in 1913; and zinc concentrates, 3,344 pounds against 68,216 pounds in 1913. Crude ore shipped to smelters contained 23,626,771 pounds of copper against 31,994,380 pounds in 1913. The crude copper ores smelted contained 17,209,706 pounds, of which 14,524,872 pounds were from sulphide ores and 2,684,834 pounds from oxidized ores. Lead ores smelted produced 4,354,094 pounds of copper, the sulphide ores yielding 2,488,068 pounds and the oxidized ores 1,866,026 pounds. Copper-lead ores, all of which were oxidized, contained 90,083 pounds of copper. The dry or siliceous ores, used principally for fluxing at smelting plants, contained 1,972,888 pounds against 1,447,177 pounds in 1913. Copper ore from the low-grade copper-bearing porphyries at Bingham and Newhouse contained 125,777,441 pounds of copper against 126,364,491 pounds in 1913 and 102,662,335 pounds in 1912.

Source of mine production of copper in Utah, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	8,227	1,369,726	111,593	.....	22,342	1,511,888
Boxelder	.....	205,473	.....	.....	.....	205,473
Cache	.....	.....	305	.....	.....	305
Grand	.....	1,374	.....	.....	.....	1,374
Juab	1,950,462	2,389,916	933,743	10,653	401	5,285,175
Piute	1,260	1,445	930	.....	.....	3,635
Salt Lake	13,791	138,968,650	2,569,944	76,284	522,840	142,151,509
Summit	46,355	.....	1,107,010	.....	14,290	1,167,655
Tooele	409	51,142	1,230,799	12,938	.....	1,295,288
Utah	.....	.....	17,483	1,919	.....	19,402
Wasatch	.....	495	176,132	.....	215,671	392,298
Total	[a] 2,020,504	142,988,221	6,147,939	101,794	775,544	152,034,002

[a] Includes 12,440 pounds from gold ore, 1,777,510 pounds from gold and silver ore, 222,885 pounds from silver ore, and 7,669 pounds from iron ore.

LEAD.

The mine production of lead in Utah in 1914 was 171,323,137 pounds, exceeding the output of any previous year, and was 5,196,347 pounds more than the output in 1913. Bingham or West Mountain district, with 76,453,128 pounds, had the largest production in 1914, against 71,001,138 pounds in 1913 and 43,822,495 pounds in 1912. The greatest part of the production at Bingham came from the Utah Apex, Highland Boy, Bingham New Haven, Brooklyn, and Dalton & Lark mines. The Park City region produced 32,323,066 pounds of lead, against 41,808,713 pounds in 1913. The Tintic district produced 36,510,911 pounds, against 26,279,312 pounds in 1913. The combined production of the Ophir and Rush Valley districts in Tooele County aggregated 12,611,432 pounds, against 14,054,788 pounds in 1913. The output in Beaver County decreased from 10,454,583 pounds in 1913 to 9,337,928 pounds in 1914. Lead contained in concentrate recovered at milling plants and shipped to smelters amounted to 55,404,883 pounds, against 53,140,609 pounds

in 1913. The lead concentrates averaged 21.55 per cent of lead in 1914 and 20.83 per cent in 1913; zinc concentrates contained 261,569 pounds, averaging 1.10 per cent of lead in 1914 and 2.87 per cent in 1913. The total crude ore of shipping grade contained 115,424,056 pounds, against 110,168,122 pounds in 1913. Sulphide lead ore contained 59,671,375 pounds of lead, against 63,765,938 pounds in 1913. The oxidized lead ores carried 53,773,366 pounds, against 43,312,981 pounds in 1913. Zinc-lead ores shipped direct to smelters contained 1,060,762 pounds in 1914, against 871,435 pounds in 1913. Of the zinc ores shipped in 1914 the oxidized ores contained 82,547 pounds of lead and the sulphide ores 978,215 pounds. Copper-lead ores, all of which were oxidized or carbonate ores, contained 234,425 pounds of lead.

Source of mine production of lead in Utah, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	15,604	.....	6,200,126	.....	3,122,198	9,337,928
Boxelder	.....	1,755	20,072	.....	.....	21,827
Cache	.....	.....	9,273	.....	.....	9,273
Juab	668,715	.....	31,355,506	35,553	27,989	32,087,763
Morgan	.....	.....	1,079	.....	.....	1,079
Piute	94,876	.....	24,956	.....	.....	119,832
Salt Lake	12,200	424	66,252,457	180,194	12,933,217	79,378,492
Summit	22,652	.....	22,382,775	.....	183,037	22,588,464
Tooele	.....	.....	12,914,459	53,522	.....	12,967,981
Utah	.....	.....	5,000,961	3,107	71,828	5,075,896
Wasatch	.....	.....	2,212,036	.....	7,522,566	9,734,602
Total	[a] 814,047	2,179	146,373,700	272,376	23,860,835	171,323,137

[a] Includes 1,696 pounds from gold ore, 35,476 pounds from gold and silver ore, 763,993 pounds from silver ore, and 12,882 pounds from iron ore.

ZINC.

The mine production of zinc (calculated as spelter) in Utah in 1914 was 15,989,267 pounds, valued at $815,453, against 18,857,827 pounds, valued at $1,056,038, in 1913. Beaver County was again the principal producer of zinc, most of it from the Horn Silver mine, which yielded sulphide ores of both milling and shipping grades. The zinc output of Beaver County was 7,143,746 pounds in 1914, against 5,522,324 pounds in 1913; and Bingham or the West Mountain distric followed next with 4,121,977 pounds, against 3,421,724 pounds in 1914. The Park City region declined in output from 4,980,206 pounds of zinc in 1913 to 3,173,313 pounds in 1914, and the Tintic district from 3,596,544 pounds in 1913 to 758,217 pounds in 1914. Lead-zinc ores, of which 153,102 tons were concentrated, produced 11,831 tons of zinc concentrate, containing 8,869,280 pounds of zinc, against 9,134,638 pounds in 1913. Crude ore smelted contained 7,103,646 pounds of zinc, of which 2,984,486 pounds were derived from zinc ores and 4,119,160 pounds from lead-zinc ores. In 1914 the sulphide zinc and lead-zinc ores predominated and produced, respectively, 1,622,122 pounds and 3,938,684 pounds of zinc. The oxidized zinc ores contained 1,362,364 pounds of zinc and the oxidized lead-zinc ores 180,476 pounds.

Source of mine production of zinc (spelter) in Utah, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Beaver	.....	1,622,122	5,521,624	7,143,746
Juab	.....	240,529	23,674	264,203
Salt Lake	.....	8,804	4,121,977	4,130,781
Summit	16,341	.....	140,410	156,751
Tooele	.....	752,097	.....	752,097
Utah	.....	360,934	164,193	525,127
Wasatch	.....	.....	3,016,562	3,016,562
Total	16,341	2,984,486	12,988,440	15,989,267

Zinc ore and concentrates produced from Utah mines and mills sold in 1914, according to source, by counties.

County.	Classification.	Quantity.	Average assay of ore or concentrates.[a]
		Short tons (dry weight).	*Per cent of zinc.*
Beaver	Sulphide ore	8,485	38.61
Juab, Salt Lake, Tooele, and Utah	Mixed carbonate and siliceous ore	2,641	34.40
Beaver, Juab, Salt Lake, Summit, and Wasatch.	Concentrates	11,869	44.07
Total	Ore and concentrates	22,995	40.94

[a] Actual zinc content.

METAL MINING INDUSTRY IN UTAH IN 1914.

During the first half of 1914 most of the mining properties in Utah were operating at full capacity, promising an increased output of ore, from the treatment of which it would have been possible to break all records of metal production in the State, but in August the copper producers were obliged to curtail their output. Consequently many employees were laid off or put on half time, and the production in the last quarter of 1914 was about half of the production in the second quarter. A slump in prices of metals caused a number of the other metal producers to curtail production and some of them to close down. One of the largest mining operators, the Utah Copper Co., placed all its employees at the Bingham mines and the Arthur and Magna mills and on the Bingham & Garfield Railway on half time and reduced its output of copper 50 per cent. More than 4,000 men are said to have been affected directly, as well as the employees of one of the smelting companies which smelts the copper concentrates of the company.

Considerable attention was given to the Big and Little Cottonwood districts in the way of opening some of the old properties, which had been idle a number of years. In the Cardiff mine particularly, a large body of silver-lead ore is reported to be developed. Some shipments of the ore have already been made by wagon to the Salt Lake Valley smelters.

Some excitement was occasioned by the finding of placer gold in the region north of Beaver City, in Beaver County, embracing the

Newton and the Fortuna districts. In this region considerable development and prospecting of placer ground and quartz lodes was in progress during 1914, but no production was recorded other than that from the Sheep Rock property. In Washington County, the Bull Valley or Goldstrike district will be a producer of gold bullion from deep mines in 1915. A small stamp mill was erected and some gold has already been shipped at the close of 1914. Mining companies in Utah disbursed $7,431,017 in dividends in 1914, against $5,677,129 in 1913.

METALLURGICAL INDUSTRY.

Mills using either amalgamation or cyanidation process are limited to a few districts in Utah. Amalgamation was used in 1914 in Beaver, Boxelder, Juab, and Washington counties. A 3-stamp amalgamation mill was erected in the Bull Valley district of Washington County at the close of 1914. Cyanidation of ores was carried on at the Sheep Rock mill in Beaver County, at the May Day waste dump in Tintic district, and in the Gold Mountain (Kimberly) district in Piute County. Very low grade ores were under treatment by the Koering cyanidation process on the Wasatch-Utah property south of Salt Lake City, at the mouth of Little Cottonwood canyon. Of the 24 milling plants operated in 1914 in Utah, 2 were amalgamation and 2 cyanidation plants, 15 were concentration plants, and 2 plants were equipped for both concentration and cyanidation. Three plants included in the total were equipped for chloridizing-roasting and leaching, but all three were not productive.

Ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Utah in 1914, by counties.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Beaver and Boxelder	271	16.84	6	99.74	662	$2,779
Juab, Piute, Salt Lake, Tooele, Utah, and Washington	1,895	89.40	72	[a] 533.35	10,874	18,927
Total	2,166	106.24	78	[a] 633.09	11,536	21,706

[a] Includes gold and silver by cyanidation from 15,500 tons of old tailings from concentration mill in Juab County.

Chloridizing-roasting was practiced at the Knight-Christensen mill [1] at Silver City and at the Ontario mill at Park City. Another plant for the same process of leaching, by converting the metals into chlorides, was erected by the Park City mills to treat custom ores containing silver, gold, lead, and copper. Scrap iron is used principally to precipitate the metals. The mill was built by remodeling the Grasselli zinc plant. The Ontario mill,[2] equipped with the same

[1] Destroyed by fire Apr. 6, 1915.
[2] Dismantled in June, 1915, and machinery moved to Silver City, Utah.

process, operated steadily in 1914 until the later part of the year, when it became necessary to store the silver bullion on account of the low price of silver. Concentration of the copper ores is confined to those of the Bingham district; low-grade lead-silver ores are treated at mills in all the principal districts. Near Garfield the Magna and Arthur mills of the Utah Copper Co. treated an average of about 22,000 tons a day during the second quarter of 1914, but after the European war broke out the mills treated only about half of that quantity. At Park City the Daly West concentrator was reconstructed for the treatment of its low-grade lead-zinc ores. The mill is situated a short distance down the hill from the old No. 2 mill destroyed by fire. The flotation process, as a means of saving additional values, is being considered at Park City, and the process is understood to have been installed at the Utah Apex mill at Bingham. A concentration mill was erected at Eureka in the Tintic district to treat the low-grade lead-silver ores of the Chief and other mines. The results have not been published. Twenty pounds of quicksilver were consumed during 1914 at milling plants and 7,396 pounds of potassium and sodium cyanide. This corresponds to 0.108 ounce of mercury per ounce of gold and silver and 0.036 pound of mercury per ton of ore treated. The consumption of cyanide was 0.607 pound per ounce of gold and silver and 0.432 pound per ton of ore and tailings treated.

MINE PRODUCTION IN UTAH IN 1914.

The following tables show the quantity of ore treated and of concentrates recovered with the yield of metals, by counties, in 1914, and the kinds of concentrates and the metal contained in each kind; also the average metallic content in 1914 compared with the average content in 1911, 1912, and 1913, by kinds of concentrate:

Mine production of gold, silver, copper, lead, and zinc from Utah concentrates in 1914.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	70,056	11,436	375.58	54,859	1,061,623	2,165,299	1,582,940	$344,474
Juab	54	30	16.15	1,188	401	17,306	7,391	2,096
Piute	.....	130	48.16	5,797	1,226	94,876	.....	8,065
Salt Lake	7,268,472	435,903	49,191.79	973,783	126,023,903	33,534,843	4,121,977	19,834,646
Summit	61,037	12,889	1,226.42	453,321	125,132	6,129,825	156,751	539,738
Tooele	74,625	23,475	312.06	272,296	912,031	5,940,168	.....	509,997
Wasatch	49,095	16,595	574.72	353,749	215,671	7,522,566	3,016,562	683,412
Total	7,523,339	500,458	51,744.88	2,114,993	128,339,987	55,404,883	8,885,621	21,922,428

By kinds of concentrates.

Siliceous		62	67.00	1,638	.....	3,680	.....	$2,434
Copper		360,569	35,863.89	358,486	125,778,515	.....	.....	17,668,157
Lead		127,958	15,739.60	1,695,790	2,558,128	55,139,634	.....	3,753,816
Zinc		11,869	74.39	59,079	3,344	261,569	8,885,621	498,021

Kinds of concentrate and average metallic content of each kind produced at concentration mills in Utah in 1911–1914.

Kind of concentrate.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1913	22	$51.68	64.73	.....	.....	.....	$90.82
1914	62	22.34	26.42	.....	2.97	.....	39.26
Copper:							
1911	228,583	3.85	1.89	23.18	.....	.....	62.79
1912	261,941	2.91	1.33	19.67	.....	.....	68.32
1913	382,663	1.65	.85	16.51	.....	.....	53.30
1914	360,569	2.06	.99	17.44	.....	.....	49.00
Lead:							
1911	107,006	1.46	17.90	.65	21.35	.....	31.80
1912	103,999	1.37	21.61	1.11	21.88	.....	38.02
1913	129,413	1.37	16.82	1.09	20.83	.....	32.71
1914	127,958	2.54	13.25	.10	21.55	.....	29.34
Zinc:							
1911	21,482	.06	5.69	.03	2.56	30.62	40.38
1912	14,992	.35	11.69	.28	3.13	35.74	60.62
1913	13,802	.29	9.76	.25	2.87	33.09	46.54
1914	11,869	.13	4.97	.01	1.10	37.43	41.96
Copper-lead:							
1911	291	.27	31.00	5.04	7.88	.....	36.40
1912	426	.05	35.23	7.06	10.18	.....	54.18

Four smelters in Utah were active in 1914—the Garfield copper plant, and the Murray, Midvale, and International lead plants. The last-named plant is equipped with copper furnaces also, which were in operation. The new Cottrell plant[1] for the electrostatic treatment of converter gases at the Garfield copper smelter was placed in operation in 1914 for the recovery, principally, of lead fume.

Mine production of gold, silver, copper, lead, and zinc from Utah crude ore shipped to smelters in 1914.

By counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	21,259	486.66	222,344	442,241	6,765,122	5,560,806	$739,275
Boxelder	987	8.41	3,256	205,473	21,827	.....	30,154
Cache	10	.....	39	305	9,273	.....	425
Grand	6	2.08	171	1,374	.....	.....	320
Iron	6	2.18	2,200	.....	.....	.....	1,262
Juab	272,831	44,592.83	4,433,636	5,284,769	32,070,410	256,812	5,340,334
Morgan	13	.....	5	.....	1,079	.....	45
Piute	256	249.96	4,080	2,409	24,956	.....	8,716
Salt Lake	544,673	55,245.95	1,651,760	16,115,028	45,789,966	8,804	5,985,015
Summit	31,387	2,762.03	1,674,126	996,168	16,435,987	.....	1,756,382
Tooele	21,868	456.78	282,742	383,257	7,027,813	752,097	529,214
Utah	11,147	1,260.74	264,407	19,120	5,070,587	525,127	399,357
Wasatch	5,865	159.71	182,695	176,627	2,212,036	.....	214,092
Total	910,308	105,227.33	8,721,461	23,626,771	115,429,056	7,103,646	15,004,591

By kinds of ore.

Dry or siliceous	89,246	17,274.07	1,005,761	1,972,888	686,949	.....	$1,202,458
Copper	471,626	62,091.43	1,367,744	17,209,706	2,179	.....	4,328,883
Lead	337,233	25,793.35	6,297,819	4,354,094	113,444,741	.....	9,019,330
Zinc	4,670	.....	.....	.....	.....	2,984,486	152,209
Copper-lead	1,077	65.42	33,941	90,083	234,425	.....	41,245
Lead-zinc	6,456	3.06	16,196	.....	1,060,762	4,119,160	260,466

[1] Howard, W. H., Electrical fume separation at Garfield: Am. Inst. Min. Eng. Trans., vol. 92, p. 2028, 1914.

Crude ore, by kinds, produced in Utah, and average metallic content of each kind shipped to smelters in 1911–1914.

Kind of crude ore.	Quantity.	Average metallic content.					Average gross value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	189,424	$5.30	12.94	0.86	0.67	.....	$14.91
1912	196,846	5.23	17.33	.84	.45	.....	19.08
1913	127,253	3.17	13.90	.57	.40	.....	13.69
1914	89,246	4.00	11.27	1.11	.38	.....	13.47
Copper:							
1911	640,729	2.36	3.01	2.55	.03	.....	10.34
1912	572,354	2.46	3.82	2.18	.19	.....	12.19
1913	662,892	3.19	3.00	1.94	.01	.....	10.63
1914	471,626	2.72	2.90	1.82	.....	.....	9.18
Lead:							
1911	261,333	1.82	20.66	.50	16.12	.....	28.51
1912	252,888	1.68	20.06	.60	16.42	.....	30.80
1913	357,196	1.76	17.47	.64	14.99	.....	27.49
1914	337,233	1.58	18.67	.65	16.82	.....	26.74
Zinc:							
1911	1,316	.....	.....	.....	.....	33.35	38.02
1912	9,391	.22	1.55	.....	3.33	29.80	45.30
1913	15,300	.....	.89	.....	2.85	30.77	37.51
1914	4,670	.....	.....	.....	.....	31.95	32.59
Copper-lead:							
1911	2,219	.98	32.83	6.28	16.41	.....	48.85
1912	3,387	1.04	40.96	4.32	12.58	.....	51.82
1913	2,740	.52	37.93	4.47	16.60	.....	51.90
1914	1,077	1.25	31.51	4.18	10.88	.....	38.30
Lead-zinc:							
1911	8,033	.17	1.03	02	10.76	23.69	37.46
1912	1,402	.....	.44	.....	7.18	26.90	43.86
1913	569	.....	.06	.....	12.45	26.98	41.22
1914	6,456	.....	2.51	.....	8.22	31.90	40.34

Oxidized and sulphide crude ores with metal content, by kinds, including mixed dry ores and carbonate ores, produced in Utah and shipped to smelters in 1914.

Kind of ore.	Quantity.	Metal content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	89,246	17,274.07	1,005,761	1,972,888	686,949	.....	$1,202,458
Copper:							
Oxidized	63,028	14,616.22	631,860	2,684,834	1,755	.....	1,008,715
Sulphide	408,598	47,475.21	735,884	14,524,872	424	.....	3,320,168
Lead:							
Oxidized	178,622	16,513.64	4,271,466	1,866,026	53,773,366	.....	5,048,831
Sulphide	158,611	9,279.71	2,026,353	2,488,068	59,671,375	.....	3,970,499
Zinc:							
Oxidized	2,268	.....	.....	.....	.....	1,362,364	69,481
Sulphide	2,402	.....	.....	.....	.....	1,622,122	82,728
Copper-lead:							
Oxidized	1,077	65.42	33,941	90,083	234,425	.....	41,245
Lead-zinc:							
Oxidized	373	3.06	865	.....	82,547	180,476	12,964
Sulphide	6,033	.....	15,331	.....	978,215	3,938,684	247,502
Total	910,308	105,227.33	8,721,461	23,626,771	115,429,056	7,103,646	15,004,591

Oxidized and sulphide crude ores and average metallic content, by kinds, produced in Utah and shipped to smelters in 1913–14.

Kind of ore.	Quantity.	Average metallic content.					Total value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1913	127,253	0.15	13.90	0.57	0.40	.....	$13.69
1914	89,246	.19	11.27	1.12	.38	.....	13.47
Copper:							
Oxidized—							
1913	168,802	.18	7.39	2.60	.04	.....	16.34
1914	63,028	.23	10.02	2.13	.....	.....	16.00
Sulphide—							
1913	494,090	.08	1.50	1.72	.....	.....	7.87
1914	408,598	.12	1.80	1.78	.....	.....	8.13
Lead:							
Oxidized—							
1913	147,315	.13	29.64	.52	14.70	.....	35.17
1914	178,622	.09	23.91	.52	15.05	.....	28.26
Sulphide—							
1913	209,881	.05	8.93	.72	15.19	.....	22.09
1914	158,611	.06	12.78	.78	18.81	.....	25.03
Zinc:							
Oxidized—							
1913	8,020	.....	.....	.....	.....	28.82	32.28
1914	2,268	.....	.....	.....	.....	30.03	30.64
Sulphide—							
1913	7,280	.....	1.86	.....	5.99	32.92	43.26
1914	2,402	.....	.....	.....	.....	33.77	34.44
Copper-lead:							
Oxidized—							
1913	1,819	.02	43.78	4.45	20.33	.....	58.51
1914	1,077	.06	31.51	4.18	10.88	.....	38.30
Sulphide—							
1913	921	.04	26.49	4.52	9.21	.....	38.85
Lead-zinc:							
Oxidized—							
1913	569	.....	.06	.....	12.45	26.98	41.22
1914	373	.01	2.32	.....	11.07	24.19	34.76
Sulphide—							
1914	6,083	.....	2.52	.....	8.04	32.37	40.69
Total:							
1913	1,165,950	.10	8.68	1.37	4.72	.42	16.25
1914	910,308	.11	9.58	1.30	6.34	.39	16.48

Mine production of gold, silver, copper, lead, and zinc in Utah in 1914, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ozs.		*Fine ozs.*			*Fine ozs.*	
Beaver	.....	.....	1,002.18	$20,717	$20,717	288,821	$159,718
Boxelder	.....	.....	19.83	410	410	3,259	1,802
Cache	.....	.....	.....	.....	.....	39	22
Garfield	13.50	$279	.....	.....	279	2	1
Grand	1.64	34	2.08	43	77	171	94
Iron	.....	.....	2.18	45	45	2,200	1,217
Juab	.....	.....	45,137.36	933,072	933,072	4,444,996	2,458,083
Morgan	.....	.....	.....	.....	.....	5	3
Piute	.....	.....	381.49	7,886	7,886	11,676	6,457
Salt Lake	.....	.....	104,465.81	2,159,500	2,159,500	2,629,153	1,453,922
Summit	.....	.....	4,063.55	84,001	84,001	2,418,564	1,337,466
Tooele	.....	.....	796.64	16,468	16,468	555,038	306,936
Uinta	44.41	918	.....	.....	918	7	4
Utah	.....	.....	1,272.84	26,312	26,312	264,532	146,286
Wasatch	.....	.....	734.43	15,182	15,182	536,444	296,653
Washington	.....	.....	23.22	480	480	9	5
Total	59.55	1,231	157,901.61	3,264,116	3,265,347	11,154,916	6,168,669

Mine production of gold, silver, copper, lead, and zinc, etc.—Continued.

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaver	1,511,888	$201,081	9,337,928	$364,179	7,143,746	$364,331	$1,110,026
Boxelder	205,473	27,328	21,827	851	.....	.....	30,391
Cache	305	41	9,273	362	.....	.....	425
Garfield	.....	.....	.....	.....	.....	.....	280
Grand	1,374	183	.....	.....	.....	.....	354
Iron	.....	.....	.....	.....	.....	.....	1,262
Juab	5,285,175	702,928	32,087,763	1,251,423	264,203	13,474	5,358,980
Morgan	.....	.....	1,079	42	.....	.....	45
Piute	3,635	483	119,832	4,673	.....	.....	19,499
Salt Lake	142,151,509	18,906,151	79,378,492	3,095,761	4,130,781	210,670	25,826,004
Summit	1,167,655	155,298	22,588,464	880,950	156,751	7,994	2,465,709
Tooele	1,295,288	172,273	12,967,981	505,751	752,097	38,357	1,039,785
Uinta	.....	.....	.....	.....	.....	.....	922
Utah	19,402	2,580	5,075,896	197,960	525,127	26,782	399,920
Wasatch	392,298	52,176	9,734,602	379,650	3,016,562	153,845	897,506
Washington	.....	.....	.....	.....	.....	.....	485
Total	152,034,002	20,220,522	171,323,137	6,681,602	15,989,267	815,453	37,151,593

Ore sold or treated, number of deep mines producing, and value of ores in Utah in 1913 and 1914, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1914	Increase (+) or decrease (−), 1914.	1913	1914	1913	1914	1913	1914
	Short tons.	*Short tons.*						
Beaver	94,521	− 73,637	24	21	$8.84	$11.74	$1.37	$1.91
Boxelder	997	− 5,721	3	5	15.35	30.48	.89	2.22
Cache	10	+ 10	.....	1	.....	42.50	.....	2.20
Grand	6	− 12	1	1	21.44	53.33	21.44	22.83
Iron	6	+ 4	2	4	323.00	210.33	321.50	210.33
Juab	288,886	− 95,091	56	44	18.86	18.55	12.42	11.74
Millard	.....	− 12	1	.....	23.83	.....	.58	.....
Morgan	13	− 39	1	1	21.56	3.46	1.25	.23
Piute	1,457	− 10,352	7	7	5.11	13.38	4.88	9.84
Salt Lake	7,813,351	−1,382,273	51	60	3.17	3.31	.36	.46
Summit	181,992	− 34,301	15	10	17.21	13.55	8.97	7.81
Tooele	96,593	− 50,890	29	26	10.41	10.77	4.00	3.35
Utah	11,187	− 6,999	18	18	30.68	35.75	10.51	15.43
Wasatch	54,960	+ 726	2	5	18.57	16.33	7.22	5.67
Washington	35	+ 35	.....	1	.....	13.85	.....	13.85
Total	8,544,014	−1,658,552	210	204	4.39	4.35	1.12	1.10

[a] Value per ton, placer product excluded.

REVIEW BY COUNTIES.

BEAVER COUNTY.

Production of metals in Beaver County, 1860–1914, by periods.

Period.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total. value.
	Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1860–1880	$57,261	3,416,200	.....	40,423,682	.....	$5,990,574
1881–1890	79,918	8,619,705	1,316,290	153,423,042	.....	16,471,318
1891–1900	96,413	4,584,667	2,912,204	111,605,913	.....	8,111,517
1901–1910	308,465	2,490,364	26,646,396	54,112,423	8,507,656	9,065,713
1911	47,568	201,259	3,739,282	4,534,678	64,927	829,406
1912	34,115	256,064	3,040,400	7,652,669	1,176,186	1,118,787
1913	23,108	344,437	3,137,234	10,454,583	5,522,324	1,486,671
1914	20,717	288,821	1,511,888	9,337,928	7,143,746	1,110,026
Total	667,565	20,201,517	42,303,694	391,544,918	22,414,839	44,184,012

Beaver County has a record of production beginning in 1860 and amounting in value of gold, silver, copper, lead, and zinc to $44,184,012 in 1914. This includes $667,565 in gold, $18,949,907 in silver, $6,604,757 in copper, $16,709,004 in lead, and $1,252,779 in zinc. The corresponding table of production by years is given in Mineral Resources for 1913, page 389.

In 1914 there were 21 mines producing 94,521 tons of ore, against 24 mines producing 168,158 tons in 1913. The total value of the output of ore for gold, silver, copper, lead, and zinc decreased from $1,486,671 in 1913 to $1,110,026 in 1914. All the metals decreased in quantity of output with the exception of zinc, which increased also in value from $309,250 in 1913 to $364,331 in 1914. The value of the gold decreased from $23,108 in 1913 to $20,717 in 1914, and of the silver from $208,040 to $159,718. The output of copper valued at $486,271 in 1913 decreased to $201,081 in 1914, and that of lead from $460,002 in 1913 to $364,179 in 1914. The average value per ton of the ore, including some old slag, increased from $8.84 in 1913 to $11.74 in 1914, and the gold and silver value per ton in this ore from $1.37 to $1.91. The difference in the total value was caused chiefly by the decrease in production of copper on account of the closing of the Cactus mine. Of the ore mined, 70,056 tons were concentrated, and produced copper, lead, and zinc concentrates carrying values in gold and silver and having a total value of $344,474, or $30.12 a ton. The copper came from the concentration of low-grade copper ores at Newhouse, and the lead and zinc from concentration of Horn Silver lead-zinc ores at Midvale. Crude ore shipped aggregated 21,259 tons, largely sulphide with some carbonates, and yielded at smelters gold, silver, copper, lead, and zinc, having a total value of $739,275, or an average value per ton of $34.77.

Beaver Lake district.—Thirty-four tons of oxidized copper ores were shipped from the O. K., Copper Mountain, and Beaver Lake properties in 1914.

Newton district.—The Sheep Rock property was the only producer. It was worked by lessees, who treated gold and silver ore in a cyanidation and concentration plant. This district is situated about 9 miles north of Beaver City. Considerable interest was caused by the discovery about 3 miles farther north of gold values in lode claims and erosion material. Examination of the placer deposits is reported under way. This new region, known as Fortuna, has been recently described.[1]

Rocky district.—The Copper Ranch and the Montreal properties produced 177 tons of oxidized copper ore in 1914, which carried some silver.

San Francisco district.—Six producers reported an output of 86,810 tons of ore and old slag, containing $11,974 in gold, 153,812 ounces of silver, 1,435,845 pounds of copper, 5,494,252 pounds of lead, and 7,143,746 pounds of zinc, valued in all at $866,607. In 1913 the production was 140,361 tons of ore and slag, having a total metal value of $1,030,927. The Cactus mine produced much the largest output, nearly all of which was milled and produced copper concentrate. The Horn Silver mine, with the next largest output, produced mixed lead sulphide and carbonate ore, and also considerable zinc sulphide

[1] Strickland, R. H., Deseret Evening News, Salt Lake City, Dec. 19, 1914.

ore, part of which was shipped to Midvale for concentration and part to eastern refineries. The old slag shipped from the property was produced in the early days of smelting. There were shipped in 1914 from the Horn Silver property [1] 15,834 tons of lead ore, 6,833 tons of zinc ore, 249 tons of zinc concentrate, and 33 tons of lead concentrate, and also 1,172 tons of old slag from early smelter operations.

The company's report says:

> Our operations during the past year have been characterized by an endeavor to continue our development out of the proceeds from the shipment of ore under rather difficult market conditions. * * *
>
> Out of a force of 70 men employed at the mine, 30 are engaged in development work. We have reached the 1,000-foot level and have secured the mine above this point so that it is safe. Our development on the 1,000 and 1,200 foot levels is, as I have pointed out, of the greatest importance.
>
> The main shaft was also retimbered from the 900 level to the 1,000 level, and old workings on the 500 level, 1,000 level, and 1,100 level retimbered preparatory to further development.
>
> There remains in sight in the mine approximately 10,000 tons of ore, but this is, of course, no index to the life of the property, as we have from time to time uncovered other ore by our development plans.

Star districts (North and South).—Six producers shipped 7,096 tons of ore directly to smelters, against 8,728 tons shipped by 10 producers in 1913. The total output was valued at $236,115 and contained $5,887 in gold, 131,426 ounces of silver, 58,286 pounds of copper, and 3,840,954 pounds of lead, with an average value per ton of $33.27, as against a total output valued at $284,828 in 1913 and an average value per ton of $32.63. The largest producer was the Moscow mine, whose output was lead-silver oxidized ores. The property is opened by a vertical shaft 800 feet deep, with numerous drifts and winzes. The other important producers of more than 200 tons each were the Monitor, Red Warrior, and the Lady Bryan and Hub groups.

BOXELDER COUNTY.

Lucin district.—Shipments of oxidized copper ore were made from the Copper Mountain group, and a small shipment of oxidized lead ore was made from the Tecoma mine.

Park Valley district.—The Susannah property was operated only a short time during 1914, and the total proceeds were small. Recovery of the gold was made by amalgamation in a 100-ton Lane mill.

CACHE COUNTY.

In the Blacksmith Fork canyon, about 13 miles east of Hyrum, are situated the Lucky Star and the Tip Top properties, which produced in 1914 a small quantity of oxidized lead ore and also some ore containing a large percentage of zinc. Some development work has been done on the properties.

GARFIELD COUNTY.

On Crescent Creek several hundred cubic yards of gravel were washed by booming and a small quantity of gold was recovered.

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[1] Horn Silver Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

GRAND COUNTY.

Grand River district.—About 14 miles from Cisco is situated the Hamlin placer property, which was operated in 1914 by the Big Six Mining Co. for about 30 days by the sluicing method and produced a small quantity of gold.

La Sal district.—The property of the Green Mountain Co. was operated in 1914, producing copper ore containing gold and silver.

IRON COUNTY.

Stateline district.—Shipments were made of rich silver ore from the Ophir mine and from other properties where small streaks of silver were mined.

JUAB COUNTY.

The output of ore by 44 producers in 1914 was 288,886 tons, containing gold, silver, copper, lead, and zinc, valued at $5,358,980, a decrease of 95,091 tons in quantity and of $1,882,380 in value, as compared with the output by 56 producers in 1913 of 383,977 tons, valued at $7,241,360. Nearly all the ore was from the Tintic district.

Detroit district.—The E. P. H. property, situated near Juab, produced a small quantity of oxidized copper ore carrying 4 ounces of silver and $4 in gold per ton and 12 per cent copper. This ore was taken out many years ago, and this clean-up of the dump was the beginning of work which it is said will continue during 1915, when a larger production is expected from the mine.

Fish Springs district.—During the early part of the year lessees worked over the dump of the Utah mine, which yielded 331 tons of lead product carrying gold and silver. Later in 1914 the mine was closed indefinitely.

Mount Nebo district.—The Eva property, a producer of lead and zinc ore, was operated during the latter months of the year and yielded a few tons of ore. The Nebo Star was also a producer of lead ore containing silver and a trace of copper.

Spring Creek district.—The Queen of Sheba mine, which is equipped with a 5-stamp amalgamation mill, produced some gold and silver bullion.

Tintic district.—A brief review and foot notes to table giving the metallic production by years from 1869 to 1913 were published in the previous report for 1913.[1] The output of the district by periods from 1869 to 1914, inclusive, is as follows:

Production of metals in Tintic district, Juab and Utah counties, Utah, 1869–1914, by periods.

Period.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1869–1880	$747,268	1,605,545	3,179,628	10,353,378	.....	$4,190,594
1881–1890	1,277,230	11,692,031	9,911,245	54,318,428	.....	16,884,489
1891–1900	6,873,756	31,366,185	21,441,370	187,524,539	.....	38,749,351
1901–1910	15,117,527	42,480,374	76,565,474	282,103,533	.....	64,029,151
1911	1,633,396	5,514,702	10,922,154	23,572,966	.....	6,982,241
1912	1,900,731	7,073,104	13,339,126	24,356,041	3,709,737	9,803,640
1913	1,412,462	5,829,484	9,261,867	26,279,312	3,596,544	7,726,755
1914	953,790	4,666,944	5,290,471	36,510,911	758,217	5,700,837
Total	29,916,160	110,228,369	149,911,335	645,019,108	8,064,498	154,067,058

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, pp. 392–393, 1914.

The total value of the metals produced from 1869 to the end of 1914 was $154,067,058, distributed as follows: Gold, $29,916,160; silver, $73,181,995; copper, $22,377,425; lead, $28,095,431; zinc, $496,047.

A large part of the Tintic district is in Juab County, with the smaller portion in Utah County. The following table gives the number of producers, quantity of ore, and quantity of metal produced in each county:

Mine production of Tintic district in 1913 and 1914, by counties.

County.	Year.	Number of mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
			Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Juab	1913	43	382,708	66,879.99	5,570,347	9,257,871	22,043,780	629,463	$7,187,167
	1914	36	287,526	44,935.80	4,406,689	5,274,672	31,542,528	247,920	5,310,138
Utah	1913	8	17,722	1,447.86	259,137	3,996	4,235,532	2,967,081	539,588
	1914	10	10,960	1,203.80	260,255	15,799	4,968,383	510,297	390,699
Total	1913	51	400,430	68,327.85	5,829,484	9,261,867	26,279,312	3,596,544	7,726,755
	1914	46	298,486	46,139.60	4,666,944	5,290,471	36,510,911	758,217	5,700,837

The value of the metals produced was distributed as follows: Gold, $953,790 in 1914, against $1,412,462 in 1913; silver, $2,580,820 in 1914, against $3,521,008 in 1913; copper, $703,632 in 1914, against $1,435,590 in 1913; lead, $1,423,926 in 1914, against $1,156,289 in 1913; and zinc, $38,669 in 1914, against $201,406 in 1913.

In 1914 the bulk of the ore mined by 46 producers was of shipping grade, only one lot going to the lead and zinc concentrating plant at Midvale, Utah. No ore was concentrated in the district, but preparations were under way for future treatment of the low-grade lead ores by concentration. The total value of the metallic output of the district amounted to $5,700,837, or an average value per ton of ore sold or treated of $19.10. In 1913 the output was valued at $7,726,755, or an average value per ton of $19.30. In both years much of the old dump material of early mining found a ready market; it is included in the total output. In the following table the quantity and kinds of ore produced, the number of producers, and the metallic content of each kind of ore are given for the year 1914:

Mine production of Tintic district, Juab and Utah counties, in 1914, by kinds of ore and metallic output of each.

Kind of ore.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry or siliceous	15	102,704	17,223.36	992,752	1,950,462	668,679	.....
Copper	12	61,377	14,557.65	621,714	2,382,398	.....	.....
Lead	31	132,768	14,345.26	3,047,562	946,557	35,717,581	.....
Zinc	7	1,064	.....	.....	.....	.....	586,633
Copper-lead	2	180	6.36	2,875	10,653	35,553	.....
Lead-zinc	5	393	6.98	2,041	401	89,098	171,584
Total	.....	298,486	46,139.60	4,666,944	5,290,471	36,510,911	758,217

Tests were made at the Eureka plant of the Utah Mineral Concentrating Co., which built a concentration plant the latter part of 1914, equipping it with rolls, tube mill, and Isbell concentrators. Low-grade ores from various parts of the Tintic district, and from the Chief mine especially, are intended for treatment in the plant. The chloridizing process installed in the mill,[1] completed the latter part of 1913 at Silver City to treat the ores of the Iron Blossom, Colorado, Beck Tunnel, and other holdings known as the Knight mines, was not sufficiently perfected in 1914 to operate successfully. The ores from the mines mentioned are said to afford an excellent variety of oxidized, sulphide, and siliceous material from which to make a mixture most suitable to the process of treatment. Silver is the metal of principal value; copper, gold, and lead also occur, and are of importance in about the order named. In metal contents the different ores range from 4 to 30 ounces of silver and 0.03 to 0.20 ounce of gold per ton, 1 to 8 per cent of lead, and from a trace to 1.75 per cent of copper. The sulphides provide the fuel necessary in the chloridizing roast, and in this respect the metallurgical conditions differ from those in the plant using a similar process at Park City, where coal is added to the ore mixture before roasting. Otherwise the process is similar, except in method of application. Briefly, it consists in roasting a mixture of ores and salt; condensing the acid roaster gases in salt solution; leaching the roasted ore with this solution and precipitating the metals successively—gold and silver on copper, then copper on lead, and electrolyzing the final lead solution.[2]

The largest ore producers in the district in 1914, named in order of production, were the Centennial-Eureka, Iron Blossom, Chief Consolidated, Mammoth, Eagle and Blue Bell, Gemini, and Grand Central. The shipments from the Mammoth property consisted largely of dump material, the grade of which was too low to ship in the earlier days of smelting.

The Centennial-Eureka mine[3] in 1914 produced 58,365 tons of ore, against 100,442 tons in 1913. The following is from the company's report:

> Shipments from the mines of this company show a further decline both in tonnage and grade. The amount extracted during the year was 58,365 tons, all of which came from old, known ore bodies. Development work failed to disclose any new ore shoots. Work is being continued on various promising leads in an endeavor to find new ore bodies.
>
> On Bullion Beck & Champion Mining Co.'s property, the majority of which is owned by the Centennial-Eureka Mining Co., work of development was continued without any important results. A number of leasers are at work. The ore produced yielded not quite enough profit to cover the expenses on the property. There is considerable promising territory in the mine, the prospecting of which is being continued.

In 1914 the Eagle and Blue Bell mine[4] produced 32,736 dry tons of ore, containing 1,444 ounces of gold, 555,411 ounces of silver,

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[1] Knight-Christensen mill destroyed by fire Apr. 6, 1915. Rebuilding in June and installing equipment using same process from the Ontario mill abandoned by the Mines Operating Co., Park City, Utah, in June, 1915.

[2] Chloridizing ores at Silver City, Utah: Metall. and Chem. Eng., December, 1914, p. 757. Article includes flow sheet of Knight-Christensen mill and illustrations and full description of process.

[3] United States Smelting & Refining Co. Ninth Ann. Rept., for year ending Dec. 31, 1914.

[4] Bingham Mines Co. Ann. Rept. for year ending Dec. 31, 1914.

8,588,565 pounds of lead, and 31,443 pounds of copper, valued in all at $513,235.69. The net returns were $226,749.93 after freight, smelting, assaying, and sampling costs were deducted.

The company's report says:

The property was operated throughout 1914, and notwithstanding the low price of metals prevailing since July, * * * the output and earnings compare favorably with 1913. * * *

The principal development during the year was the opening in March of No. 1 ore deposit on the 1,550 level. This ore body has proven one of the most persistent, both in metal contents and in size, that was ever developed within the property, and its full extent is yet to be determined. It has not only netted the company a considerable profit, but has also demonstrated the great extent of the ore zone laterally.

Having followed this ore to the 1,600-foot level through a winze, it was deemed advisable to sink the main operating shaft from the 1,550 to the 1,700 level. This work was started in September and completed in October. A station was made at the 1,700 and the level extended northeasterly. At a point under the No. 1 stope, 1,550 level, the ore has been encountered, proving conclusively its persistence to this depth. It is also making below the level. * * *

On account of the splendid indications for ore at greater depths, the main shaft was sunk 150 feet. At the 1,700 level a station was cut and the level extended northeasterly to a point directly under the No. 1 stope, 1,550 level. Recent developments have proven the persistence of the ore to this depth, so we intend to advance the 1,700-foot level to a point directly under the 1,538 ore body.

A drift was driven 210 feet on the 1,350 level to prospect for the upward extension of the No. 1 ore body on the 1,550 level. The lime conditions here are very favorable, and we will continue to explore in this vicinity at the first opportunity.

The 1,350 north drift was advanced 290 feet, and the face is now 500 feet distant from the ore encountered by the Chief Consolidated Co., while driving its 1,000 level across our North Extension claims.

The output of the Colorado mine[1] in 1914 was 2,947 tons of lead ore containing 430.22 ounces of gold, 97,565.01 ounces of silver, 1,057,312 pounds of lead, and 1,336 pounds of copper, valued in all at an average per ton of $28.56. The following paragraphs are from the company's report:

Following the systematic clean-up, mentioned in the report of last year, the leasing system was duly considered and adopted. This system, thus far, has given satisfactory results. On account of so much bad ground and so many dangerous places in the old stopes of the mine, this leasing system has proved to be very advantageous to the company, owing to the fact that it releases the company from all accident liability and saves many other expenses incident to mining in such places.

An abstract of the principal points embodied in the form of lease employed is submitted herewith:

Lessees make all shipments of ore in the name of the company and pay royalties as follows on the net payments per ton according to smelter settlement sheets, after treatment charge has been deducted:

	Per cent royalty.
Valuation not over $10	20
Valuation $10 to $15	25
Valuation $15 to $20	30
Valuation $20 to $25	35
Valuation $25 to $30	40
Valuation $30 and above	50

[1] Colorado Mining Co. Ann. Rept. for year ending Nov. 1, 1914.

All lessees are under the direct supervision of the mine superintendent in regard to the use of mine cars, drifts, blacksmith shops, ore bins, etc., and are required to move from the mine all rock, earth, and low-grade ores broken, instead of using the same for filling in the present openings and openings which may be made during the life of the respective leases, without such latter action being first agreed to by the superintendent in charge of the mine.

All blocks of ground containing a considerable quantity of low-grade or "mill ore" have been reserved from the leasing system with a view of having this ore treated by the Knight-Christensen process.

From the Iron Blossom[1] No. 1 mine shaft 16,451 tons of ore was shipped that contained 2,292.80 ounces of gold, 374,637 ounces of silver, 1,963,714 pounds of lead, and 177,557 pounds of copper, valued in all at an average per ton of $18.33. The No. 3 mine shaft produced 24,029 tons, containing 3,592.63 ounces of gold, 763,308 ounces of silver, 5,958,924 pounds of lead, and 16,300 pounds of copper, valued in all at an average per ton of $24.89. Aside from having a considerable quantity of smelting ore blocked out, the company reports having developed a large quantity of low-grade ore, and it is reported that it carries metals valued at $6 to $12 a ton and can be mined at low cost. This ore is expected to be treated by the Knight-Christensen process, which is still in the experimental stage.

The Lower Mammoth mine[2] produced 1,259 tons of lead ore and 336 tons of zinc ore in 1914.

The following extract is from the company's report:

During the past year we have confined our prospecting chiefly to the territory overlying and adjacent to the immense low-grade zinc deposit between the 1,500 and 1,800 levels that has been partially developed in the past few years. * * * I estimate this tonnage of partially developed ore at 200,000 tons, assaying about 13 per cent zinc. This is in the form of zinc carbonate and zinc silicate. * * * The 336 tons of zinc ore was shipped to eastern smelters and 1,259 tons of copper and lead ore to the local smelter. This zinc ore of shipping grade is found in lenticular lenses throughout the mass of low-grade zinc mentioned above.

At the Chief Consolidated mine[3] 39,629 tons of ore were shipped, valued net at $290,907.53 after the payment of smelting, transportation, sampling, and other charges. The metal content of this ore was 6,291 ounces of gold, 645,419 ounces of silver, 5,782,118 pounds of lead, and 71,665 pounds of salable zinc. The average content was 0.1588 ounce of gold and 16.29 ounces of silver per ton of ore, and 12.68 per cent of lead (in lead ore) and 29.13 per cent of zinc (in zinc ore).

The following extract is from the company's report:

The expert geological investigation of the company's mine and mining lands has been continued throughout the year and has resulted in a clearer comprehension of the complexities which exist as a consequence of the numerous faults crossing the section. * * *

A few months since ore was discovered in a neighboring mine, owned by the May Day Mining Co., making into a part of three claims, owned by your company, situated about a mile from your mine. A short-time lease was given to the May Day Co. and some of the ore mined through that company's workings. This ore was of very excellent grade and yielded good profit, but on account of

[1] Iron Blossom Consolidated Mining Co. Ann. Rept. for year ending Dec. 1, 1914.
[2] Lower Mammoth Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[3] Chief Consolidated Mining Co. Sixth Ann. Rept., for year ending Dec. 31, 1914.

the lowering of the prices of the metals its mining has been for the time discontinued. * * *

The crosscut on the 800 level, connecting the 1,000 ore system with the shaft, was completed and served for the transportation of all the available waste from the development drifts on the other levels for filling the old 1,025 stope. * * *

On the 1,400 ore system a small tonnage was mined between the 1,400 and 1,600 levels and a winze was sunk from the 1,600 to the 1,700 on high-grade ore. A drift on the 1,800 is being driven.

A new ore body known as the 1,410K has been found about 100 feet north of the 1,400 ore system on the 1,400 level. The opening out of this is giving a good product of high-grade silver ore with occasional good gold values.

West Tintic district.—During 1914 lead oxidized ore carrying silver and gold and a small quantity of copper was shipped from the Scotia mine. New interests have taken hold of the property under lease and bond, and the production is likely to be much larger for the year 1915.

MORGAN COUNTY.

Argenta district.—A small quantity of oxidized lead ore was shipped from one of the properties in the district in 1914.

PIUTE COUNTY.

Gold Mountain district.—Shipments of gold and silver ore were made from the Annie Laurie mine in 1914. This property was an important producer in earlier years. No other production was recorded for the district.

Ohio district.—In 1914 the Bully Boy property was operated until its cyanidation and concentration plant was destroyed by fire. A very small quantity of ore was treated while the mill was in operation. The Shamrock and three other properties added to the total output, which was valued at $12,886.

SALT LAKE COUNTY.

Sixty operators in Salt Lake County produced 7,813,351 tons in 1914, which was 1,382,273 tons less than was produced in 1913 by 51 producers. The total average value per ton of the ore for the gold, silver, copper, lead, and zinc content increased from $3.17 in 1913 to $3.31 in 1914, and the gold and silver average value per ton in this ore increased from $0.36 to $0.46. The larger part of the ore was mined by steam shovels at Bingham and was shipped to Garfield for concentration.

Big and Little Cottonwood districts.—With the output in 1914 included, since 1867 these districts have produced 314,742 tons of ore, valued at $20,936,525, which value includes $451,607 in gold, $11,735,903 in silver, $1,164,304 in copper, $7,584,262 in lead, and $449 in zinc. These figures are corrected and revised from an estimate published in the report for 1913.[1]

The table giving the combined production of the two districts by periods follows.

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 397, 1914.

Production of metals in Big and Little Cottonwood mining districts, 1867–1914, by periods.

Period.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1867-1870 [a]	5,573	$1,240	703,138	.....	6,444,800	.....	$1,321,955
1871–1880 [b]	133,796	74,109	6,259,000	.....	95,201,998	.....	13,401,008
1881–1890 [c]	22,515	112,184	883,034	.....	14,784,900	.....	1,703,068
1891–1900 [d]	13,885	156,721	707,731	.....	8,457,869	.....	1,005,819
1901 [e]	935	3,332	37,532	.....	300,298	.....	38,764
1902	850	3,029	34,120	58,490	272,999	.....	39,442
1903	1,977	1,762	69,336	102,260	552,483	.....	76,417
1904	4,878	6,333	106,249	235,832	1,190,005	.....	148,703
1905	26,003	19,638	371,683	811,639	1,702,258	.....	450,756
1906	20,801	15,753	345,102	1,193,743	1,922,276	.....	586,933
1907	19,896	20,195	399,417	1,074,238	2,337,924	.....	622,568
1908	5,866	6,643	63,246	269,212	603,840	.....	101,061
1909	13,208	6,940	158,867	1,842,711	332,475	.....	343,400
1910	14,203	7,894	202,010	804,018	1,102,907	.....	267,617
1911	6,040	2,877	158,448	407,719	1,043,608	.....	184,783
1912	6,566	2,945	186,183	386,963	1,135,191	.....	232,381
1913	5,167	2,317	93,821	136,901	1,091,617	.....	128,235
1914	12,583	7,695	242,825	214,971	2,887,109	8,804	283,615
Total	314,742	451,607	11,021,742	7,538,697	141,364,557	8,804	20,936,525

[a] J. R. Browne (Mineral resources of the States and Territories west of the Rocky Mountains, 1868, p. 486) refers to the operation (in 1867) of two small furnaces in Cottonwood Canyon. These furnaces were under construction in 1866 according to the Daily Union Vedette of Aug. 25, 1866, and in September began producing lead, which evidently was lost in slag and cinders (Vedette, Oct. 26, 1867), and recovered in 1867 by a German metallurgist named Reese under the supervision of A. A. Hirst, who had reconstructed the works for treatment of North Star ores. According to R. W. Raymond (Mining statistics of the States and Territories west of the Rocky Mountains, 1870, p. 223) the first efficient smelter (a cupola one), erected by Woodhull Bros. 7 miles south of Salt Lake City, began to operate in June, 1870, producing 5,000 pounds of bullion in 36 hours. Most of the ore was from the Monitor and Magnet claims (idem, p. 222). Shipments of ore from the Emma mine (located August, 1868) began in June, 1870, and up to Dec. 31, 1870, Walker Bros. had shipped 4,200 tons of ore (mostly Emma, with an average assay of 35 per cent of lead and $182 in silver per ton). Lead bullion shipments mostly from Cottonwood ores, were 2 tons to England and 6¼ tons to San Francisco (op. cit., 1872, p. 319). In the fall of 1870 mining locations in Big Cottonwood district, the Davenport, Theresa, Wandering Boy, Maxfield, and Prince of Wales, had each produced some ore for shipment (idem, p. 321). On the Little Cottonwood side, the Emma mine had produced up to August, 1871, 10,000 to 12,000 tons of ore, which assayed 100 to 216 ounces of silver per ton and from 30 to 66 per cent of lead, and averaged 160 ounces of silver and from 45 to 50 per cent of lead. The total value of the ore, at the cash price paid for it, a large part of it at Liverpool, was about $2,000,000 (idem, p. 323). The Flagstaff mine, up to April, 1871, had produced over 80 tons of shipping ore.

[b] Between 1871 and 1880 the largest producers were the Emma (largely depleted by 1873), Flagstaff, North Star, and Vallejo (Joab Lawrence Co.), City Rock, Grizzly, and Lavinia, Davenport, Savage and Montezuma, Reed & Benson, and Prince of Wales. According to Huntley (Tenth Census of the United States, vol. 13, 1880, p. 423) the Emma mine had yielded to June 1, 1880, ore amounting to 27,451 tons, for which $2,637,727 was received (idem, pp. 423–424). The rich ore bodies of the Flagstaff mine gave out in December, 1873, having produced about 31,000 tons, which probably assayed $10 in gold, 60 ounces of silver, and 40 per cent of lead, and sold for $80 a ton. Between 1874 and 1879 about 69,000 tons were produced from the Flagstaff, probably assaying $4 in gold, 30 ounces of silver, and 20 per cent of lead, and selling for $30 a ton, a total value from the beginning of about $4,550,000 (idem, p. 428). The Prince of Wales-Antelope group of claims were discovered about 1870, and had a record of producing more than $1,000,000 to the end of 1882, according to U. S. Mint Rep., 1884, p. 421. Subsequent records of the Prince of Wales in the reports of the mint to 1890 show not more than 10,121 tons of ore shipped, averaging, probably, 105 ounces of silver and 30 per cent of lead.

[c] Between 1881 and 1890 the Flagstaff produced in 1881; the Joab Lawrence or Vallejo and City Rocks produced almost continuously to 1891; and the Maxfield was the heaviest shipper in the years 1884, 1887, 1888, and 1890.

[d] In 1891 and 1892 the Maxfield and the Flagstaff were the principal producers. Between 1891 and 1900 very little or no mention of these districts was made in the reports of the Director of the Mint. The figures given are differences between the known output of other districts in Salt Lake County and that of the Cottonwoods as given by the Director of the Mint in the reports for each year.

[e] Compiled from producers' reports to the United States Geological Survey.

In 1914 more ore was developed in the mines than for many years previously, and the production of 12,583 tons was nearly equal to the outputs made in 1909 (13,208 tons) and 1910 (14,203 tons). Most of the ores mined in these two years was of milling grade. The largest shipper in 1914 in the Big Cottonwood district was the Cardiff mine, and on the Alta side the properties of the Michigan-Utah, which include the Black Bess and City Rocks groups, were worked by lessees. Next in importance of production was the South Hecla property. All these properties produce largely an oxidized silver-lead ore.

Copper sulphide ore, with some lead sulphides and carbonates, was found in the Cardiff property. Altogether 12,583 tons of ore were produced in 1914, against 5,167 tons in 1913. This ore, with the exception of a small quantity containing gold, was all shipped directly to the smelters and produced $7,695 in gold, 242,825 ounces of silver, 214,971 pounds of copper, 2,887,109 pounds of lead, and 8,804 pounds of zinc, having a total value of $283,615, or an average value per ton of $22.54. The zinc was contained in ores shipped from the Carbonate mine in Big Cottonwood Canyon, from which large shipments were commenced early in 1915. The Salt Lake and Alta Railroad, 11 miles long, connecting Midvale with Wasatch, was finished November 20, 1913, and its terminus was connected with an aerial tramway, about 3 miles long, which supplies a number of the Alta producers with transportation. Other mine companies not accessible to the tramway haul about 2½ miles by wagon to the loading bins of the railroad at Wasatch. The cost of transportation from Alta to the smelter, which varies according to the grade of the ore, was, in 1914, from $1.50 to $2.50 a ton, a reduction from former costs. On the Big Cottonwood side of the district all the ore is hauled 16 miles by wagon to the smelters at a cost of about $4 a ton. The producers on that side of the district in 1914 were the Cardiff, Maxfield, Carbonate, and Prince of Wales lease, including the mill output of the Wasatch-Utah property situated near the mouth of Little Cottonwood Creek canyon. The shippers from Alta in 1914 were the Alta Consolidated, Cabin, Wasatch (Columbus and Flagstaff), North Star, Michigan-Utah, and South Hecla.

Very heavy snowfalls during the winter months interfere with mining in the region, and disastrous snowslides are not infrequent. Little Cottonwood canyon is a typical glacial canyon[1] with a large terminal moraine at its mouth and a lateral moraine on the south side. The sides of the canyon are precipitous and rock exposures are found all the way to the head. In succession, coming up the canyon, are quartzite, granite, quartzite, limestone, and overlying quartzite. The quartzite and limestone dip 35° N. 60° E. An extract on this particular section, recently described,[2] follows:

> The upper contact of the lime and quartzite is attracting considerable attention at the present time. This contact strikes northwest 30° and dips 35° easterly. It is cut by several fissures striking northeasterly and southwesterly; also by another series striking more easterly and westerly. All these fissures dip in a northerly direction.
>
> The large ore body of the old Columbus, called No. 5 stope, was formed at the intersection of the Brain fissure and this contact. About $1,500,000 worth of ore was taken out of this stope. Recently the Cardiff developed a large ore body at the intersection of this contact and the South Fork fissure. * * *
>
> These ore bodies are a replacement of the lime. The mineralization is due to the fissures, and the lime only affords a field where small fissures can make large ore bodies. So much has been said of this contact lately that a great many people believe the mineralizing agents followed the contact. This is not true, as the contact is barren except in the vicinity of an ore-bearing fissure. It is true that the fissures have mineralized the contact some distance each way, but that is only on account of the solubility of the lime.
>
> It is the recent development of this new ore body in the Cardiff that has given the present impetus to Alta mining. It has not the earmarks of a boom, but there is considerable activity, and more is expected.

[1] Atwood, W. W., Glaciation of the Uinta and Wasatch mountains: U. S. Geol. Survey Prof. Paper 61, pp. 82–88, 1909.

[2] Some Alta activities: Eng. and Min. Jour., vol. 99, pp. 689–690, Apr. 17, 1915.

The Columbus Extension drove approximately 5,000 feet of crosscut tunnel in a northerly and northwesterly direction, cutting five well-defined fissures. These were all cut in the overlying quartzite, and no attention was given to the contact. These fissures are from 2 to 15 feet wide. Some shipping ore has been mined and a large tonnage of mill ore defined. One of these bodies of mill ore is a replacement in a bed of soft quartzite and is about 30 feet wide. * * *

The objective of the Columbus Extension tunnel was the big Toledo fissure. This strikes northeasterly and southwesterly, the filling cropping near the top of the ridge, and dips about 60° in a northerly direction. This is the strongest and most persistent fissure in the camp. In the early days a great deal of high-grade silver ore was mined from the Toledo fissure from the surface to a depth of 400 or 500 feet. The Extension tunnel will cut this fissure at a vertical depth of 1,400 feet.

The present management crosscut from the face of the tunnel 230 feet to the contact with the intention of following the contact to the Toledo fissure, feeling assured of a large ore body at the fissure. After drifting only 85 feet there was cut an unknown fissure 5 feet wide, striking northeast 20°, on which they are now drifting into the lime. * * * The face of the contact drift has advanced 100 feet beyond this zinc fissure and shows 2 feet of vein material on the contact, with some zinc and copper ore scattered through it. The Columbus Extension is working 10 men at present. Compressed air and electric power are furnished by the Wasatch Mines Co. The electric power is used for driving a 30-inch fan connected for suction through a 10-inch pipe line. * * *

The South Hecla owns 550 acres of ground on the south side of Little Cottonwood canyon, almost directly opposite the Columbus Extension. At present this company is drifting on the Wedge fissure in the lime. This is a northeast-southwest fissure. It has been opened 800 feet on the 250-foot level and 900 feet on the 500-foot level. The property is worked through a tunnel and the levels are referred to perpendicular distances from the surface. * * * There are 5 miles of underground workings, and the property is splendidly equipped throughout. Ore is shipped only during the summer months. Last year 5,000 tons were sent to the smelter, for which $104,000 was received. Fifteen men are working at present, but the force is greatly increased during the summer. * * *

The Alta Consolidated claims are developed by 500 feet of tunnels and other underground workings and have produced about $100,000 gross since incorporation. The latest work in the west drift from the tunnel level on the Brain fissure has developed 1½ feet of rich sulphide ore. * * * At the present time a winze is being sunk on this ore to intersect a quartzite-lime contact which is similar to the one which made the large ore bodies in the Columbus Consolidated and the Cardiff. The east drift is being driven to get under the ore body of the old Matilda mine, which was a heavy producer in the early days and is now a part of the Alta Consolidated holdings. There is also a large bedded vein, 40 feet thick, of sulphide ore carrying copper, gold, and silver, traversing the property northwesterly and southeasterly for approximately 1,500 feet.

Progress is being made on the Alta Tunnel & Transportation Co.'s adit, which, at the close of 1914, was being driven at the rate of 5 feet a day, almost reaching the 1,000-foot point of its final length of 5,000 feet. The tunnel is driven for the transportation of ore and for the development and drainage of many famous producing mines in the vicinity of Alta at a depth 600 feet lower than any of the present workings. The tunnel was started on the Big Cottonwood side of the district and will develop the Lucky Dutchman group of claims lying between the Honeycomb fault on the east, the Silver Fork fault on the west, and northward to the property of the Prince of Wales mine. On the Alta side of the mountain the Tunnel Co. controls a group of claims, to which point the tunnel is projected.

Smelter district.—From the vicinity of the operating smelters more or less old slag is sorted and shipped from year to year. The output in 1914 was only 107 tons, containing gold, silver, copper, and lead. The old slag dumps of early smelting are about exhausted.

West Mountain or Bingham district.—From 1865 to and including 1914 the output of Bingham was valued at $24,079,403 in gold, $29,961,276 in silver, $149,156,539 in copper, $36,412,468 in lead, and $1,085,708 in zinc, a total gross value of $240,695,392, out of which dividends (partly estimated) amounting to $34,291,448 have been paid.

Production of metals in West Mountain or Bingham district, Utah, 1865–1914, by periods.[a]

Period.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1865–1880	$1,426,926	4,940,097	2,058,900	124,430,704	.....	$14,550,312
1881–1890	878,924	6,364,168	2,155,780	157,485,700	.....	14,668,372
1891–1900	1,762,171	5,256,464	16,726,571	140,501,994	.....	13,315,275
1901–1910	12,017,572	13,661,758	478,607,954	158,296,838	4,221,889	96,808,262
1911	2,281,943	2,786,810	129,995,865	46,576,337	4,715,121	22,373,132
1912	1,785,532	2,028,496	116,621,793	43,822,495	2,711,982	24,434,792
1913	1,774,815	2,408,692	144,920,494	71,001,138	3,421,724	29,608,007
1914	2,151,520	2,383,051	141,924,811	76,453,128	4,121,977	25,537,240
Total	24,079,403	39,829,536	1,033,012,168	818,568,334	19,192,693	240,695,392

[a] Includes revisions of the figures published in this report for 1913. See U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p, 399, 1914.

In 1914 the output of ore in the district was 7,800,661 tons, against 9,190,374 tons in 1913 and 6,567,948 tons in 1912. The total metallic value of the ores in 1914 was $25,537,240, or an average value per ton of $3.27, against an output valued at $29,008,007, or an average value per ton of $3.16 in 1913. The output of gold increased from $1,774,815 in 1913 to $2,151,520 in 1914. The production of silver decreased slightly in value to $1,317,827 in 1914 from $1,454,850 in 1913. The production of copper decreased in value from $22,462,676 in 1913 to $18,876,000 in 1914, and that of lead from $3,124,050 in 1913 to $2,981,672 in 1914; but the zinc increased in value from $191,616 in 1913 to $210,221 in 1914. The shipment of ore to the smelters was 532,130 tons, against 655,634 tons in 1913, 502,682 tons in 1912, and 661,852 tons in 1911. The output of concentrating ores was 7,268,472 tons, against 8,527,755 tons in 1913 and 6,060,018 tons in 1912. The quantity of concentrates produced was 435,903 tons in 1914, against 443,640 tons in 1913 and 307,613 tons in 1912. The crude smelting ore in 1914 consisted principally of low-grade copper and lead sulphides and contained 54,882.72 ounces of gold, 1,408,938 ounces of silver, 15,900,057 pounds of copper, and 42,902,857 pounds of lead, valued in all at $5,701,588, or an average value per ton of $10.71. The milling ores produced 435,903 tons of copper, lead, and zinc concentrates that contained 49,191.79 ounces of gold, 973,783 ounces of silver, 126,023,903 pounds of copper, 33,534,843 pounds of lead, and 4,121,977 pounds of zinc, valued in all at $19,834,646, or an average value per ton of $45.50.

The number of mines and the kinds of ore and the metals produced in 1914 are given in the following table:

Output of ore and production of metals in Bingham district, Utah, in 1914, by kinds of ore.

Kind of ore.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry or siliceous	5	4,220	261.35	4,515	12,961	11,147	.....
Copper	14	7,454,927	83,122.55	1,079,276	138,943,069	424	.....
Lead	22	249.003	12,967.17	1,011,101	2,445,941	63,508,340	.....
Lead-zinc	4	92,511	7,728.73	288,159	522,840	12,933,217	4,121,977
Total	.....	7,800,661	104,079.80	2,383,051	141,924,811	76,453,128	4,121,977

The Utah Copper property[1] in 1914 produced concentrates containing 121,779,401 pounds of copper. After making smelter deductions the net production was 115,690,445 pounds of refined copper, 34,729 ounces of gold, and 325,351 ounces of silver. This output was from 6,470,166 tons of ore handled in 1914 at both the Magna and the Arthur plants. The actual sales of copper in 1914 were made at an average of 13.41 cents, or, after deducting delivery charges, 13.256 cents a pound.

The company's annual report says:

The total dividends up to and including the dividends paid during the year under discussion aggregate $25,817,815. * * *

No underground work was done in the original Utah Copper group, but 9,030 feet of tunnels, drifts, and raises were driven in the original Boston group, making the total length of all underground work at the end of the year 448,533 feet, or 84.94 miles. In the areas that have been mined by steam shovels or stoped from underground workings, the total length of such workings destroyed or rendered inaccessible up to the end of the year was 338,226 feet, or 64.05 miles leaving 20.89 miles still accessible.

Previous to 1914 seven diamond drill holes and 67 churn drill holes had been driven, having a combined depth of 37,471 feet. During the year work on three of the above-mentioned churn drill holes was completed and 10 additional churn drill holes were drilled, the combined depth of which was 8,920 feet. Therefore the total combined depth of all drill holes at the end of 1914 was 46,391 feet, making an average depth per hole of 552 feet.

The cost of underground development for the year was 0.88 cent per ton on the total tonnage of all ores mined and shipped to the plants from both underground workings and steam shovels, and the cost of churn drill development was 0.82 cent per ton on all ore produced. Therefore the total cost of both underground and surface development amounted to 1.70 cents per ton of ore mined, as compared with 2.34 cents per ton for 1913. * * *

Revised calculations, taking into account the results of the year's work, show that previous to January 1, 1915, there had been developed in the property 377,690,400 tons of ore, of which quantity 269,640,000 tons are classed as fully developed and 108,050,400 tons as partially developed. This tonnage includes about 28,700,000 tons of partially developed ore in the slopes of the steam shovel workings. The year's addition to reserves was 10,000,000 tons in excess of the tonnage mined during that period.

The average assay of the fully developed ore is 1.57 per cent copper and the average assay of the partially developed ore is 1.16 per cent copper, making the

[1] Utah Copper Co. Ann. Rept. for year ending Dec. 31, 1914.

average assay of both classes of ore 1.453 per cent copper. There was mined prior to January 1, 1915, from the entire property a total of 35,190,400 tons of ore, averaging 1.457 per cent copper, and the total reserves remaining, therefore, amount to 342,500,000 tons, averaging 1.45 per cent copper. In making the calculations to determine the average grade of the ore reserves there were used 56,714 assays, representing 334,518 linear feet of development work. * * *

The total amount of stripping removed during the year was 5,708,836 cubic yards. * * * The total amount of capping removed from the property to the close of the year was 27,834,043 cubic yards. Of this quantity, 18,309,008 cubic yards have been removed from the Utah group and 9,525,035 cubic yards from the Boston group. * * *

Underground mining operations were continued in the original Boston area until March 31, 1914, and underground development in the southwesterly portion of the ore body was prosecuted in a small way throughout the entire year. Hereafter all development will be done by churn drilling. Of the total ore mined during the year, 98.27 per cent was produced by steam shovels and 1.73 per cent was mined underground, as compared with 91.02 per cent and 8.98 per cent, respectively, for the year 1913.

The average cost of steam-shovel mining was 30.96 cents per ton. * * * The average cost of underground mining for the first three months of the year was 78.45 cents per ton, of which 22.02 cents represents the cost of the underground development to March 31, as compared with 69.52 cents and 17.72 cents, respectively, for the previous year. * * *

During the year there were milled at the Magna plant 4,461,461 tons of ore, being an increase of 318,761 tons over the previous year; while at the Arthur plant, which was not operated after August 6, 2,008,705 tons were milled, being a decrease of 1,367,987 tons, as compared with 1913. The total ore treated at both plants was 6,470,166 tons, as compared with 7,519,392 tons for the previous year. The Magna plant treated an average of 12,223 tons daily during the year, and the Arthur plant an average of 9,214 tons daily during the time it was actually operated.

* * * The recoveries were affected adversely during the year as they have been in the past by the presence of considerable quantities of oxidized copper minerals in the ores mined near the surface of the deposit. As further progress in stripping is made, this oxidized condition will gradually disappear and recoveries will improve correspondingly. * * *

The total gross production of copper contained in concentrates was 121,779,401 pounds, and the average grade of the concentrates was 18.19 per cent copper, as compared to 119,939,809 pounds and 17.31 per cent copper, respectively, for the previous year. * * *

Production of ore, assay of headings, copper recovered, and cost per pound at Utah Copper property in 1914, by quarters.

	Dry tons.	Headings (per cent).	Net production (pounds of copper).	Cost per pound (cents).
First quarter	1,962,100	1.3411	31,203,858	9.423
Second quarter	2,006,157	1.4573	38,016,694	7.539
Third quarter	1,466,606	1.4356	27,252,333	7.760
Fourth quarter	1,035,303	1.5062	19,217,560	7.731
Total	6,470,166	1.4249	115,690,445	8.131

The average total cost of mining and milling, exclusive of transportation charges, was 67.68 cents per ton, as compared with 69.64 cents for 1913, 83.91 cents for 1912, 86.47 cents for 1911, and 87.6 cents for 1910. In the cost for 1914 there is included a charge of 1.70 cents per ton to cover the cost of churn drilling and underground development, as well as a fixed charge of 7.5 cents for the retirement of the stripping expense. These mining and milling costs include all fixed, general, and maintenance charges. All operating costs for 1914 were less than those of previous years, as shown in table below.

Average cost per ton of ore of mining, transportation, and milling in property of Utah Copper Co., 1910–1914.

Year.	Tonnage.	Mining.	Transportation.	Milling.	Total.
1910	4,340,245	$0.4097	$0.2978	$0.4663	$1.1738
1911	4,680,801	.4479	.3078	.4168	1.1725
1912	5,315,321	.4233	.2848	4158	1.1239
1913	7,519,392	.3288	.2797	.3676	.9761
1914	6,470,166	.3232	.2782	.3536	.9550

As has been stated previously, the Arthur plant was shut down and operations were curtailed to a 50 per cent basis on August 6. During the first seven months of the year both plants treated a total of 4,677,657 tons of ore, or at the rate of 22,064 tons daily, averaging 1.40 per cent copper, at a cost per net pound of copper of 8.278 cents. During the last five months of the year the Magna plant treated a total of 1,792,509 tons of ore, or at the rate of 11,716 tons daily, averaging 1.49 per cent copper, at a cost per net pound of copper of 7.769 cents. Costs during the first quarter were unusually high, partly on account of weather conditions but principally because of the low-average assay of the ore, the cost for that quarter having been 9.423 cents. During the four months from April to July, inclusive, the plants treated 2,715,557 tons of ore, or at the rate of 22,258 tons daily, averaging 1.44 per cent copper at a cost of 7.579 cents per net pound. From the above figures it will be noted that the cost of production for the last five months of the year, when operations were conducted on a 50 per cent basis, was 0.509 cents less per pound of copper than for the first seven months, while it was only 0.19 cents more per net pound than for the best four months of the year, from April to July, inclusive, when both plants were operated to their full capacity. The comparatively low cost of production for the last five months was due partly to improvements in operating methods and partly to the better grade of ore treated. However, full benefit could not be derived from this higher-grade ore on account of the admixture of carbonates that obtained during the last quarter. Taking everything into consideration, the results for the last five months of the year must be considered highly satisfactory.

The Highland Boy mine[1] in 1914 produced 7,584,391 pounds of copper, 14,588,276 pounds of lead, 284,196 ounces of silver, and 15,528 ounces of gold. There was mined and shipped to the International smelter over the company's aerial tramway ore classified as follows:

Average assay per ton of crude ore shipped from the Highland Boy mine in Utah in 1914.

Material.	Dry ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounce.*	*Fine ounce.*	*Per cent.*	*Per cent.*
Copper-iron sulphide ore	153,345	.085	0.966	2.509	.....
Lead sulphide ore	48,492	.053	3.275	.755	16.713

The company's annual report says:

The profits for the year were $565,665.62. * * * During the year 19,778 feet of exploration and development was done. The most important work was as follows:

(1) In the upper limestone. Last year's report refers to a 1,500-foot crosscut being driven to open up this ground. This was completed during the period covered by the present report, and in addition 3,500 feet of drifting and raising was done and an incline shaft started, which at present is down 689 feet. The ore occurs in irregular-sized shoots with an average width of 4 feet and an

[1] Utah Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

average assay of 16 per cent of lead, 2.6 ounces of silver, and 0.043 ounce of gold. In the shaft the ore found was of the average grade in lead and has a little higher silver value. The indications, so far as we have gone below No. 7 level, are that the ore bodies will be maintained as to size and grade, but drifting and raising will have to be done before this can be definitely stated.

(2) On the No. 7 level west 1,640 feet of drifting and crosscutting was done. Most of this was in quartzite and siliceous limestone, which is not favorable for ore deposition. Recently a promising bed of limestone was found and is now being explored. A large area remains unexplored in the western part of the property, and although surface indications are that the greater part of this is quartzite with small lime beds, it is planned to continue the drifting to the west and to crosscut this formation by diamond drilling.

(3) Exploration of No. 9 level west resulted in the finding of a small copper-ore body of a good grade.

(4) Exploring on the No. 13 level. This is the deepest of the mine workings. About 3,000 feet of work was done here, but no ore of commercial grade has been found. During the coming year it is intended to continue work by drifting and crosscutting on this level, and in addition to explore at further depth.

The Bingham mines of the United States Smelting Co.[1] produced lead and copper ores, mostly sulphides. The following extract is from the company's annual report:

Work of exploration was carried on during the year on the No. 1 tunnel level, No. 2 tunnel level, and on the 400 level from the Galena shaft. A large amount of work was also done on the Niagara tunnel level, for the purpose of exploration and to prepare this level for its intended use as the main haulage level of the whole group of mines. The amount of new ore developed was sufficiently large to maintain unimpaired the ore reserves existing on the first of the year. There were no important new ore bodies found in the Niagara mine, in which this company holds a majority interest.

The operations of these mines suffered seriously on account of the large drop in quotations of silver, lead, zinc, and copper, all of which, in addition to gold, are being produced in these mines. The ore extracted during the year amounted to 92,287 tons of lead ores and 101,655 tons of copper ores. The condition of the mines both as to present ore reserves and future possibilities is excellent.

Improvements were made in almost all the departments of the smelter. The roasting plant was largely improved and increased. The old method of handling ore charges was abandoned and replaced by a mechanical device. This device was developed at the plant and is proving economical and highly satisfactory. Metallurgical costs and work show a marked improvement. Efficiency of the concentrating mill and the Huff electrostatic separating plant has also been improved. These plants, as well as the smelter, operated without material interruption throughout the year.

The Dalton & Lark mine produced 10,354 dry tons of lead ore and 18,993 tons of copper ore, and the Commercial mines, belonging to the same company,[2] produced 20,433 dry tons of copper sulphide ore. The following extract is from the company's annual report:

As compared with 1913, the output is larger by 10,792.16 dry tons, due to increased shipments of both lead and copper ores. The smelter returns are $10,678.86 less, owing to the falling off in the value of the copper ores and the very low metal market prevailing since last July.

In old workings lessees mined 3,880 dry tons of ore, the company receiving as royalty $10,539.64. * * *

The bulk of the ore from the Dalton & Lark group was obtained from the old Brooklyn mine, between the Mascotte tunnel and 1,600-foot levels. The Lark and lead mine veins produced a small tonnage of lead. The low-grade copper from the Commercial came principally from the 500, 360, and 330 foot levels. * * *

[1] United States Smelting & Refining Co. Ninth Ann. Rept., for year ending Dec. 31, 1914.
[2] Bingham Mines Co. Sixth Ann. Rept., for year ending Dec. 31, 1914.

The present ore reserves above the tunnel level are chiefly valuable for smelter flux, as you will note from the following average assay value of the 20,433 dry tons shipped during the year: Gold, 0.101 ounce; silver, 0.79 ounce; copper, 1.126 per cent; iron, 31.61 per cent; insoluble, 28.55 per cent; and lime, 0.67 per cent.

There were 693 dry tons of ore shipped from the Yosemite mine[1] in 1914, containing 20 ounces of gold, 5,538 ounces of silver, 344,963 pounds of lead, and 5,865 pounds of copper. In addition to this 37.7 dry tons were shipped from the Cluster workings.

The company's report says:

The 1,100 level on the Lark vein was extended easterly a distance of 130 feet and encountered a small lens of lead-silver ore. About 18 inches of low-grade copper and iron ore was developed almost the entire length of the drift. This level was also extended westerly a short distance and continued to develop low-grade copper ore averaging about four feet thick.

The ore produced from the Utah Apex mine[2] contained in 1914 gold, silver, copper, lead, and zinc, having a gross value of $894,456.57.

The following extract is from the company's annual report:

Throughout the fiscal year just ended the Utah-Apex Mining Co. has maintained its position as the leading lead producer of the State of Utah. Because of the physical condition of the property we are encouraged in the belief that this position will be maintained for the ensuing year. * * *

Early in the year development in the upper levels exposed the upward extension of milling ore bodies which had been previously exposed below, along the 500-level horizon. The substantial increase in mill ore reserves brought about by this development and the inadequacy of the old mill to handle a tonnage of ore commensurate with the reserves thus developed, suggested expansion of mill operations. In December reconstruction and enlargement of the milling plant was begun and shortly after April 1 the new mill was put into commission. With the exception of time lost in making repairs and in revamping some of the mill stages made necessary by the change in the character of the ore, the mill has been in continuous operation to date. * * *

Shipments of our crude ore continue to furnish us with a substantial profit per ton, but, because of limitations placed upon this class of ore by the smelter, we are unable to make the showing we are capable of making, from our lower ore bodies. Exhaustive tests on this ore by flotation process indicate that an additional profit can be made on the zinc contained in our ore and prelimiary steps have been taken to realize upon this metal. * * *

Many improvements have been made, such as increase in our power capacity and replacement of mule haulage on the 700 level by electric locomotive.

In 1914 some ore was developed and shipped from grounds covered by the Utah Metal tunnel, which was finished in 1913. However, the only income of the property at present[3] is derived from the sale of water.

SEVIER COUNTY.

None of the mines in the county were productive in 1914. The lead property near Salina was idle, as was the Sevier Consolidated property, whose output in the past has been credited to the Gold Mountain district in Piute County.

SUMMIT AND WASATCH COUNTIES.

The Park City region, embracing the Blue Ledge, Snake Creek, and Uinta districts, all credited with output in 1914, produced gold,

[1] Bingham Mines Co. Sixth Ann. Rept., for year ending Dec. 31, 1914.
[2] Utah Apex Mining Co. Ann. Rept. for year ending Aug. 31, 1914.
[3] Utah Metal Mining Co. Statement to stockholders dated May 4, 1914.

silver, copper, lead, and zinc, valued in all at $3,363,215. This value added to the value of the production of metals since 1870 amounts to the sum of $152,454,585, which includes $4,058,315 in gold, $92,970,184 for silver, $3,794,721 for copper, $48,862,756 for lead, and $2,768,609 for zinc. The dividends paid in 1914 by three companies amounted to $556,533. This amount added to that previously paid by eight known dividend payers brings the total of dividends from the district to date up to $39,309,659.

Production of metal in the Park City mining region, 1870–1914, by periods.

Period.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1870–1880	.....	6,217,716	.....	11,954,000	.....	$7,888,353
1881–1890	$369,199	27,531,180	.....	145,412,800	.....	35,008,512
1891–1900	1,107,815	31,830,831	1,563,325	295,716,775	.....	35,666,648
1901–1910	2,216,910	46,383,365	17,776,611	519,180,571	23,330,131	55,997,465
1911	102,204	3,428,651	1,281,190	47,637,642	8,596,564	4,713,236
1912	75,748	3,642,749	1,968,249	42,111,561	8,001,512	5,087,924
1913	87,256	3,717,556	1,794,170	41,808,713	4,980,206	4,729,232
1914	99,183	2,955,008	1,559,953	32,323,066	3,173,313	3,363,215
Total	4,058,315	125,707,056	25,943,498	1,136,145,128	48,081,726	152,454,585

The output of ore in the region in 1914 was 236,952 tons, as against 270,527 tons in 1913. The crude ore shipped directly to smelters consisted of mixed lead carbonates and sulphides aggregating 37,252 tons and containing 2,921.74 ounces of gold, 1,856,821 ounces of silver, 1,172,795 pounds of copper, and 18,648,023 pounds of lead, valued in all at $1,970,474, or an average value per ton of $52.90. The remainder of the ore (110,132 tons) was milled, the bulk of it producing 29,484 tons of concentrates (including concentrates from 50,000 tons of creek tailings), which contained 1,801.14 ounces of gold, 807,070 ounces of silver, 340,803 pounds of copper, 13,652,391 pounds of lead, and 3,173,313 pounds of zinc, valued in all at $1,223,150, or an average value per ton of $41.49. In 1913 the average value per ton of the shipping ore was $66.65 and of concentrates $53.27.

The crude ore and the concentrate output of the Silver King Coalition Mines Co. in 1914 was about 20,000 tons, containing principally silver and lead. For a year or more the company had been preparing for a most elaborate equipment for underground work. This was accomplished in May at the Silver Hill shaft 1,670 feet below the surface and 8,400 feet from the mouth of the Alliance tunnel. The machinery is installed in three huge chambers lined with concrete and consists of compressor, switchboard, electrical hoist, cable, and other machinery for the sinking of the 3-compartment shaft to the contact estimated to be 1,200 feet deeper.

At the Daly West property a new 200-ton concentration mill was under construction to replace the one destroyed by fire December 28, 1913, and there was no production of ore, except the small quantity taken out by lessees.

In 1914 the Daly-Judge mine[1] produced 54,701 dry tons of ore, of which 49,095 tons were of a concentrating grade, and made

[1] Daly-Judge Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

12,453 tons of lead concentrate and 4,142 tons of zinc concentrate. The ratio of concentration was 4 to 1 of lead concentrate and 3 to 1 of all products combined. There were 5,606 tons of sulphide-lead ore shipped directly to the smelter. The metal content of the total output was 723.6 ounces of gold, 519,979 ounces of silver, 384,782 pounds of copper, 9,675,220 pounds of lead, and 3,548,896 pounds of salable zinc. The 900 level of the Daly vein and the 1,200 level of the Middle vein produced the larger part of the milling ore. The quantity and content of the ore shipped and of products from ore milled are given in the company's report as follows:

Average metallic content of crude oil and concentrates of Daly-Judge Mining Co., Utah, in 1914.

Kind of material.	Dry ore.	Gold (per ton).	Silver (per ton).	Copper.	Lead.	Zinc.	Iron.	Sold for—
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Crude ore shipped	5,606	0.027	29.65	1.51	19.29	12.37	7.40	$21.35
Lead concentrates shipped	12,453	.040	24.01	.87	29.19	11.66	18.02	25.48
Zinc middlings shipped	4,142	.018	13.24	.....	2.93	42.85	7.77	17.36

To develop the Daly-Judge mine and other properties in the region at greater depth the Snake Creek adit, to be about 14,500 feet long when completed, was begun in 1910. At the end of 1910 about 3,000 feet of the adit had been completed. On January 1, 1915, the distance from the portal to the breast was 10,448 feet, a total advance of 3,751 feet for the year 1914 and an average of 341 feet per month. The best progress for one month was made in August, when an advance of 419 feet was made with only two shifts in the heading. The ground passed through is reported to be uniformly of good standing quality, and no timber was used in 1914, except where the adit encountered large fissures and watercourses. The rocks cut during the early part of the year were limestone and interbedded bands of quartzite. In the latter part of August the ground became very hard and crystalline. In September a large dike of dark igneous rock was cut, and for nearly 1,000 feet northwest of this dike was highly metamorphosed limestone, with characteristic metamorphic minerals developed. About the 1st of December the main diorite stock, which forms the backbone of the mountain range, was encountered at a depth of about 2,500 feet under the surface. No ore of commercial value was encountered in the adit during 1914, although there have been indications of it in several places. Samples were taken from several fissures which carried small quantities of lead, silver, zinc, copper, and gold, showing that ore-bearing solutions penetrated into this district. The quantity of water delivered varied greatly during the year, and on January 1, 1915, was about 4,500 gallons a minute, which was slightly in excess of the average for the year.

From the ore statement of the Silver King Consolidated[1] the ore sold aggregated 9,987 dry tons, containing 513.76 ounces of gold, 503,784 ounces of silver, 257,912 pounds of copper, and 5,593,786 pounds of lead. This ore averaged 0.0514 ounce of gold and 50.44

[1] Silver King Consolidated Mining Co. Ann. Rept. for year ending Feb. 1, 1915.

ounces of silver per ton, 1.291 per cent of copper and 28 per cent of lead, and sold for $34.74 a ton after freight and smelting charges were deducted. The following extract is from the company's annual report:

The production of ore held a secondary place in the program of our mine operations during the fiscal year ending January 31, 1915. Early in the year when we broke into our great ore deposit on the 1,500 and 1,550 foot levels, we could have begun and maintained a very large output of high-grade ore. * * *

By far the greatest part of the ore produced during the year has been from development work; that is to say, the driving of drifts and upraises in the ore to determine its extent and to expose the ore bodies in the best possible shape for economical extraction. No effort has been made to produce a large tonnage, but to the contrary, owing to the low prices for metals, the production has been restricted to the minimum amount necessary to meet operating expenses and the quarterly dividends.

The main ore of the mine is in conjunction with a fissure having an approximate east and west course. The fissure shows movements both in a vertical and east-west direction. These movements have in places ground the two sides of the fractured country rock close together, leaving little more than a small seam to follow. In other places the adjoining country rock is crushed, leaving openings between the two walls of the fissure, which formed or acted as conduits for the alkaline and mineral-bearing solutions. The fissure itself may or may not therefore carry ore at certain places. In others, notably the crushed and open sections, the ores have refilled the cavities and replaced large portions of the crushed sections.

In common with other sections of the district, certain limestones are permeable and easily dissolved by the alkaline solutions, and have therefore been wholly or in part dissolved out and replaced by commercial ores. These deposits have proven the most prolific and best producers of high-grade ores throughout the district. The distance to which this replacement may extend from the fissure is variable.

By reason of faulting the ore on the north side of the fissure is found to be some 30 feet above or higher than the ore on the south side of the fissure. That is to say, the country rock on the south side of the fracture has dropped down an average distance of 30 feet. * * *

The development work on the 1,550–1,700 levels demonstrates a large body of high-grade ore, and one that is remarkable for its persistence and regularity. As a rule ore deposits in lime are very erratic, and the ore may not be systematically opened but must be mined and followed as encountered. From the head of the 1,550 incline drift to the No. 2 raise the ore is exposed upon both sides of the drift and is continuous without a break. In thickness it varies from 2 to 5 feet. Crosscuts at two points, one being driven at a point about 100 feet down the incline drift and one south from the No. 2 raise give widths of 40 and 75 feet, respectively. The ore on the south side of the vein has also been opened at the No. 4 raise where it shows an average thickness of 4 feet and a width of 40 feet. The drift connecting No. 2 and No. 3 raises is all in ore. At No. 3 raise the drift has been raised one set high above the drift set and ore in or above this set is over 14 feet wide, with apparent ore going off both to the north and the south. The drift connecting raises No. 3 and No. 4 is all in ore and extends off to the south and north, everything indicating a large body of ore. The limit of the ore bodies vertically or laterally has not been as yet determined at any point between raise No. 2 and raise No. 4. At the head of No. 2 raise, where the ore has a demonstrated vertical thickness of 34 feet, the ore extends off to the north under the black lime. A crosscut has been driven at this point showing the ore to extend northerly a distance of 40 feet from the fissure and having a thickness of 5 to 7 feet. * * *

Dividends to the amount of $251,032.75 have been paid since the last report, making the total disbursements to date $559,823.17.

Although the Ontario Co. cleaned up the mine on the 1,500-foot level, nothing is reported to have been done toward development. The Mines Operating Co., which has a lease on the old stope fillings in the Ontario mine, operated and produced continuously a greater part of the year. At the close of the year the leaching plant[1] of the com-

[1] Dismantled June, 1915, and machinery moved to Silver City, Utah.

pany was not in operation. At the plant of the Park City mills, equipped for the leaching process to treat American Flag ores, a short run was made, which was unsatisfactory to the operators, and it was decided to make a change in the roasting furnace in which the chloridizing operation is performed. Many tests were made in the use of flotation on several ores in the district, and prospects are said to be good for the adoption of this method of concentration at three milling plants.[1]

TOOELE COUNTY.

In 1914 the production of 96,593 tons of ore was reported from Tooele County by 26 producers, against 147,483 tons and 29 producers in 1913. The average value per ton of the ore increased from $10.41 in 1913 to $10.77 in 1914, and the gold and silver value decreased from $4 in 1913 to $3.35 in 1914. The total value of the ore sold or treated, containing gold, silver, copper, lead, and zinc, was $1,039,785, against $1,535,994 in 1913. The county output consisted of 796.64 ounces of gold, valued at $16,468; 555,038 ounces of silver, valued at $306,936; 1,295,288 pounds of copper, valued at $172,273; 12,967,981 pounds of lead, valued at $505,751; and 752,097 pounds of zinc, valued at $38,357. The production of all metals decreased, gold showing a decrease of $186,196; silver, 85,211 ounces in quantity and $79,774 in value; copper, 227,308 pounds in quantity and $63,729 in value; lead 1,651,885 pounds in quantity and $137,523 in value; and zinc, 450,471 pounds in quantity and $28,987 in value. Of the total ore produced in the county in 1914, the greater part, or 94,867 tons, was classed as lead ore, of which 74,605 tons were milled; and 15,672 tons of oxidized lead ore and 4,590 tons of sulphide lead ore were shipped to the smelters. The quantity of dry or siliceous ores sold or treated decreased from 56,378 tons in 1913 to 152 tons in 1914. The output of copper ores was 268 tons and the copper-lead ores 143 tons, most of which was oxidized. The production of zinc ores decreased from 1,704 tons in 1913 to 1,163 tons in 1914. There were shipped directly to smelters 21,868 tons of ore, which contained $9,443 in gold, 282,742 ounces of silver, 383,257 pounds of copper, 7,027,813 pounds of lead, and 752,097 pounds of zinc, having a total value of $529,214, or an average value per ton of $24.20. Concentrating and jigging plants produced 23,475 tons of concentrates from the treatment of 74,625 tons of ore, and yielded $6,451 in gold, 272,296 ounces of silver, 912,031 pounds of copper, and 5,940,168 pounds of lead, valued in all at $509,997, or an average value per ton of $21.73.

Camp Floyd district.—A small clean-up of bullion was made from one of the properties in the district. The camp of Mercur was almost entirely deserted in 1914.

Clifton district.—One small shipment of bismuth gold ore and one of tungsten ore were made from the district. The former contained gold and silver, which was paid for by the purchasers of the bismuth ore.

Columbia district.—The old Sharp mine was operated by lessees, who shipped oxidized lead ore containing silver and a little gold. There is a small concentration mill on the property, but it was not operated in 1914.

[1] Daly West mill installed flotation and commenced operation in January, 1915. Installation not complete at Daly-Judge and Silver King August, 1915.

Granite Mountain district.—A small shipment of lead ore containing silver and a trace of gold was hauled by auto truck to the smelter from one of the properties in the district.

North Tintic district.—Lessees shipped a small quantity of lead-zinc ore from the Scranton mine. This property was closed during the greater part of 1914.

Ophir district.—The district produced 76,114 tons of ore, of which 60,050 tons were concentrated. The concentrates from one property, and 16,064 tons of crude ore from miscellaneous properties were shipped to the smelters. These shipments included 986 tons of zinc ore, from which it is estimated 662,785 pounds of metallic zinc was recovered. The principal producers of ore were the Ophir Hill, Cliff Mines, Hidden Treasure, Buffalo Consolidated lease on Lion Hill, and Brooklyn.

Rush Valley district.—Five operators produced 19,332 tons of ore, containing $8,686 in gold, 108,979 ounces of silver, 21,680 pounds of copper, 3,791,497 pounds of lead, and 69,582 pounds of zinc, valued in all at $223,251. The output of one producer included 14,555 tons of ore converted into concentrates, which, with 4,777 tons of crude ore from miscellaneous producers, were shipped directly to the smelters. The crude ore included ore containing zinc shipped to an eastern plant. The largest producer was the Bullion Coalition mines, in which is included the Honerine group, equipped with a concentration mill. The other producers were the New Stockton, Galena King, and Muerbrook group.

Silver Islet district.—Development work was done on several of the properties in 1914, and small shipments were made aggregating 105 tons of lead-silver ore, containing gold, silver, copper, lead, and zinc, with a total value of $8,165, or an average value per ton of $77.76.

Wild Cat Range district.—This region, situated about 18 miles south of Clive on the Western Pacific Railway, produced from a group of four patented mining claims a small quantity of silver ore containing copper. Some rich specimens of this ore contained fluorite, malachite, proustite, and flakes of native silver.

UINTA COUNTY.

Green River district.—Some gold was produced 6 miles south of the ferry station Alhandra, on Green River, at the Horse Shoe placer diggings, where the sands and gravel were carried to a new patented recovery device by a drag-line scraper. It is estimated that over 1,000 cubic yards of material were treated, from which gold 0.923 fine was recovered.

UTAH COUNTY.

Eighteen operators in 1914 produced 11,187 tons of ore, including 20 tons of old slag. This output was 6,999 tons less than that of the same number of producers in 1913. The total value of the output in 1914 was $399,920, against $557,913 in 1913. The total average value per ton of the ore increased from $30.68 in 1913 to $35.75 in 1914, and the gold and silver value per ton increased from $10.31 to $15.43. All the ore produced, including some sorted slag, was of shipping grade. Some bullion containing gold and silver was reported from a small mill test.

American Fork district.—This district is situated at the head of American Fork canyon and is separated from the Little Cottonwood district by a sharp divide. The town of American Fork, 18 miles distant by wagon road, is the supply point and loading station for ores to the smelters, transported by the Denver & Rio Grande and San Pedro, Los Angeles & Salt Lake Railroads. In 1871–72 a narrow-gage railroad was built up the canyon to a point within 4 miles of the Sultana smelter (three stacks), built about the same time. The smelter was operated irregularly until the spring of 1875 owing to the depletion of the ore bodies in the Miller mine, which was discovered in September, 1870, and operated until December, 1876. The railroad tracks were taken up in 1878 and sold for old iron. The Wild Dutchman mine was discovered in 1872 and worked until 1876, when both it and the Miller were turned over to lessees. These mines were the two largest producers of ore, and, with the Pittsburg, Sunday, Silver Bell, Orphan, Queen of the West, Live Yankee, Whirlwind, Non-Compromise, Milkmaid, and the Wasatch King, produced between 1870 and 1880 very rich ore, which, according to the best estimates available, furnished by competent authorities, was valued for the gold, silver, and lead content at $2,630,701. The table showing the production of the district, by periods, from 1870 to 1914, inclusive, follows:

Production of metals in American Fork district, Utah, 1870–1914, by periods.

Period.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1870–1880 [a]	39,950	$64,415	1,377,600	.....	14,868,000	.....	$2,630,701
1881–1890 [b]	990	10,890	32,475	.....	693,000	.....	75,366
1891–1900 [c]	1,000	4,134	22,000	.....	510,000	.....	37,665
1901 [d]	128	732	3,508	.....	76,800	.....	6,145
1902	39	73	663	.....	23,666	.....	1,394
1903	64	440	1,872	.....	11,214	.....	1,922
1904	922	16,537	18,880	.....	617,280	.....	54,352
1905	2,479	26,894	27,740	88	1,374,660	.....	108,272
1906	2,914	43,345	47,611	.....	1,959,784	.....	186,952
1907	4,706	72,017	93,551	45,098	3,612,785	.....	334,259
1908	2,356	15,411	64,840	26,073	1,386,596	.....	111,455
1909	1,025	2,587	39,821	10,670	628,148	.....	51,692
1910	965	3,785	34,204	12,227	519,749	.....	46,677
1911	494	1,634	9,441	4,092	386,544	.....	24,543
1912	659	2,510	11,172	3,466	380,630	.....	27,081
1913	411	632	6,609	2,949	279,772	2,712	17,542
1914	224	1,425	4,189	3,591	106,219	14,830	9,119
Total	59,326	267,461	1,796,176	108,254	27,434,847	17,542	3,725,137

[a] The American Fork district was organized July 21, 1870. Work was not commenced to any extent on the mining claims until the fall of that year (Murphy). The Miller mine was the principal producer, discovered in September, 1870. In 1871–72 the Sultana smelter was built for the reduction of Miller ore, and ran irregularly until the spring of 1875. The Miller ore bodies gave out and the mine was closed in December, 1876. It was in the hands of lessees at different periods to the end of 1880. D. B. Huntley (Tenth Census, vol. 13, p. 444, 1880) estimates the production of ore from the Miller mine to the end of 1880 between 13,000 and 15,000 tons, assaying from 40 to 54 per cent of lead, 30 to 47 ounces of silver, and from $2 to $10 in gold. In 1872 the Wild Dutchman mine was discovered, and worked by the company until September, 1876, when it was leased. Its total production to 1880 was estimated at 7,900 tons of ore, averaging 45 ounces of silver and 40 per cent of lead. The Pittsburg, Sunday, Silver Bell, Orphan, Queen of the West, Live Yankee, Whirlwind, Non-Compromise, and, in the Silver Lake section, the Milkmaid and the Wasatch King were producers prior to 1880.

[b] During the period 1881–1890 development work was performed, but very little ore was shipped, probably not averaging more than 100 tons a year. The Director of the Mint (Rept., 1886, p. 224) shows the aggregate shipments of the Bellerophon, Live Yankee, Milkmaid, Miller, Silver Bell, Sultana, and Wild Dutchman to have amounted to 80½ tons in 1886.

[c] In 1891 the Wild Dutchman, North Star, Kalamazoo, and Live Yankee properties produced 100 tons of ore, according to the Director of the Mint. (Rept., 1891, p. 224.) Estimates were made for the remaining years of this decade, and it is presumed the average ore yield was not greater than in 1891.

[d] For the period 1901 to 1914, inclusive, the figures of production, beginning in 1902, have been collected by the United States Geological Survey and those for the year 1901 are estimated from best records available.

Seven mining properties in 1914 produced 204 tons of ore and 20 tons of old slag, having a total value of $9,119, or an average value per ton of $40.71. The principal output came from the Miller mine, which produced lead and zinc ores. The other producing properties were the Dutchman, Bog Iron, Live Yankee, North Star, and Blue Rock.

Tintic district.—The producers in 1914 on the Utah County side were the Beck Tunnel, Colorado, East Tintic Development, May Day, Salvator, Sioux, Tintic-Standard, Uncle Sam, and Yankee Consolidated. The production is more fully reviewed under Juab County, under which the operations of the more important properties in 1914 are described.

WASHINGTON COUNTY.

Bull Valley district.—A 3-stamp mill was erected on the Hamburg property for the treatment of free gold ore, which has recently been developed by lessees. Some bullion has already been made and more will probably be produced when the mill is completed.

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GOLD, SILVER, COPPER, LEAD, AND ZINC IN MONTANA.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

GENERAL STATEMENT.

Montana mines produced during the calendar year 1914 gold, silver, copper, lead, and zinc valued at $47,849,747. This was the value of the output made by 505 producers; in 1913 there were 558 producers, and the output was valued at $61,900,546. The decrease of $14,050,799 in value in 1914 was mainly due to the reduced output of copper, although silver and lead also decreased. The value of silver, copper, and lead combined was $15,400,193 less than in 1913, while the value of the gold and zinc was $1,349,394 more. Silver Bow County, which includes the Butte or Summit Valley district, produced 16 per cent of the gold, 87 per cent of the silver, 99.5 per cent of the copper, 56 per cent of the lead, 98 per cent of the zinc, and more than 91 per cent of the total value of the product from deep mines.

The production of ore and of gold, silver, copper, lead, and zinc from 1904 to 1914, inclusive, is as follows:

Ore sold or treated in Montana, 1904–1914, number of producers, and mine production of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc. (spelter).	Total value.[a]
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	210	4,643,092	$1,267,062	12,817,285	290,681,572	2,299,291	.....	$48,974,381
1905	332	5,020,137	4,794,083	13,231,300	304,723,526	6,264,998	1,560,000	60,709,155
1906	370	5,497,971	4,469,014	11,980,705	290,700,975	4,462,979	6,579,000	69,257,083
1907	436	4,148,496	3,286,212	9,317,605	220,108,792	3,748,304	243,100	53,670,592
1908	566	4,266,022	3,057,640	10,356,199	251,667,795	4,596,570	1,640,000	42,036,710
1909	619	5,421,185	3,791,510	12,378,714	312,058,011	2,983,430	9,359,724	51,429,694
1910	578	5,079,446	3,730,486	12,162,857	284,808,553	4,106,292	31,638,184	48,358,253
1911	610	4,940,303	3,710,571	11,985,196	272,847,705	6,431,575	43,810,145	46,955,287
1912	604	5,552,164	3,625,235	12,731,638	309,738,873	7,446,749	26,918,881	64,754,613
1913	558	5,960,118	3,493,432	13,819,201	287,828,699	10,935,827	88,673,083	61,900,546
1914	505	5,128,956	4,117,911	12,016,460	233,229,640	9,656,008	111,580,544	47,849,747
Increase (+) or decrease (−) in 1914		−831,162	+624,479	−1,802,741	−54,599,059	−1,279,819	+22,907,461	−14,050,799

[a] Includes placer production.

PRODUCTION OF ORE IN 1914.

The total quantity of ore sold or treated was 5,128,956 tons, against 5,960,118 tons in 1913, a decrease of 831,162 tons, and the total average value per ton decreased from $10.25 in 1913 to $9.14 in 1914, and the value of the gold and silver contained in this ore increased from $1.85 to $1.91 per ton. Mines in Silver Bow County are credited with the largest output of ore, 4,749,189 tons. Of the ore sold or treated in Silver Bow County, 4,342,937 tons, or 91 per cent, was copper ore; 393,663 tons lead-zinc ore; 12,486 tons dry or siliceous ore; 57 tons lead ore; and 46 tons copper-lead ore. The total output of dry or siliceous ores was 342,085 tons, of which 315,804 tons were classified as gold ore, 427 tons as gold and silver ore, and 25,854 tons as silver ore. The largest part, or 186,638 tons, of dry or siliceous ore, together with 5,597 tons of old tailings, was treated by cyanidation; 29,983 tons were treated by amalgamation; and 119,767 tons were shipped directly to the smelters for treatment. Blaine and Deer Lodge counties, with 121,159 tons and 56,121 tons of ore, respectively, were the largest producers of siliceous ore, and Fergus County followed with 52,825 tons. Oxidized iron ores amounting to 56,121 tons, some of them containing more than 20 per cent excess iron and a little gold, were mined in the Georgetown district of Deer Lodge County, and a similar ore, of lower grade, was mined near Elkhorn, in Jefferson County. Iron sulphides containing nearly an ounce of gold per ton and a little silver and copper continued to be mined in Broadwater County, near Radersburg. The output of copper ore was 4,346,034 tons, of which 3,716,347 tons were of milling grade and produced 1,305,976 tons of concentrate averaging 29 cents in gold and 4.45 ounces of silver per ton and 6.37 per cent of copper, and an average value of $19.69 per ton. The copper ore of shipping grade amounted to 573,032 tons, largely sulphides, containing 26 cents in gold and 3.84 ounces of silver per ton and 5.08 per cent of copper, and an average value of $15.88 per ton. Of the 29,636 tons of lead ore produced, 7,111 tons were shipped directly to the smelters and contained $5.23 in gold and 35.42 ounces of silver per ton and 0.16 per cent of copper and 16.27 per cent of lead, and an average value of $37.93 per ton; and the remainder, or 22,525 tons, was concentrated and produced 3,415 tons of concentrates, containing $1.05 in gold and 39.92 ounces of silver per ton and 0.045 per cent of copper and 22.97 per cent of lead. Lead concentrates were also separated from lead-zinc ore, of which 401,967 tons were treated and produced 3,462 tons of lead concentrate averaging $1.33 in gold and 41.86 ounces of silver per ton and 0.32 per cent of copper and 45.42 per cent of lead. The average value per ton of the two lead concentrates combined was $51.01. Zinc concentrates recovered from zinc ore and lead-zinc ore aggregated 125,124 tons, averaging 73 cents in gold and 17.61 ounces of silver per ton, and 0.56 per cent of copper, 0.99 per cent of lead, and 44.54 per cent of zinc, the total average value being $58.15 per ton. The average metallic content and the values per ton of the concentrates and crude ores smelted appear in the sections following.

Output of ore and production of metals in Montana in 1914, by kinds of ore.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	147	.....	45,579.75	7,041	.....	.....	.....
Dry or siliceous ore	255	342,085	121,599.07	1,249,555	742,887	39,970	.....
Copper ore	63	4,346,034	25,422.61	8,015,694	231,019,109	13,871	.....
Lead ore	46	29,636	1,972.44	388,194	25,603	3,879,401	.....
Zinc ore	2	9,066	41.99	48,373	.....	.....	1,932,695
Copper-lead ore	2	168	6.63	5,271	22,215	78,147	.....
Lead-zinc ore	5	401,967	4,581.45	2,302,332	1,419,826	5,644,619	109,647,849
Total	.....	5,128,956	199,203.94	12,016,460	233,229,640	9,656,008	111,580,544

Subdivision of ore sold or treated in Montana, in 1914, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	248	264	16,800	.....	.....	.....	17,312
Blaine	121,159	.....	.....	.....	.....	.....	121,159
Broadwater	26,976	154	75	.....	.....	.....	27,205
Cascade	205	.....	7,070	.....	.....	17	7,292
Deer Lodge	56,121	.....	.....	.....	.....	.....	56,121
Fergus	52,825	.....	.....	.....	.....	.....	52,825
Granite	13,709	774	914	.....	.....	.....	15,397
Jefferson	4,328	373	2,220	9,046	.....	30	15,997
Lewis and Clark	23,895	27	1,426	.....	.....	.....	25,348
Madison	26,619	85	508	.....	.....	.....	27,212
Meagher	.....	6	.....	20	.....	.....	26
Missoula	3,244	128	229	.....	.....	8,257	11,858
Powell	238	1,286	330	.....	.....	.....	1,854
Ravalli	32	.....	7	.....	.....	.....	39
Sanders	.....	.....	.....	.....	122	.....	122
Silver Bow	12,486	4,342,937	57	.....	46	393,663	4,749,189
Total	[a]342,085	4,346,034	29,636	9,066	168	401,967	5,128,956
Value per ton in gold and silver	$9.37	$1.14	$8.62	$3.05	$18.17	$3.40	$1.91

[a] Includes 315,804 tons of gold ore, 427 tons of gold and silver ore, and 25,854 tons of silver ore.

GOLD.

The mine production of gold in Montana increased from 168,994.77 fine ounces, valued at $3,493,432, in 1913 to 199,203.94 fine ounces, valued at $4,117,911, in 1914, an increase of 30,209.17 ounces in quantity and of $624,479 in value. Madison County is credited with the largest output, $1,117,950 from deep and placer mines, the output of the latter amounting to $836,097, against $691,651 in 1913. Deep or lode mines in Deer Lodge County produced the largest part of the gold from deep mines, with Silver Bow County a close second, followed by Fergus and Broadwater counties. At amalgamation and cyanidation plants $819,444 in gold was produced, with an average recovery of $3.69 per ton of ore and tailings treated. Ore treated at concentration mills produced concentrates containing $553,400 in gold, or 38 cents per ton. The crude ore shipped to smelters contained $1,802,850 in gold, or an average of $2.58 per ton. Placer gold was produced in largest quantity in Madison County, chiefly the output of one company operating four

dredges in Alder Gulch which handled in 1914 about 6,300,000 cubic yards of gravel. The Cedar Creek dredge in Missoula County operated only a short time.

Source of mine production of gold in Montana, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Beaverhead	100.62	293.10	6.00	65.45	.....	.....	.....	465.17
Blaine	.....	11,408.91	.....	.....	.....	.....	.....	11,408.91
Broadwater	196.40	23,539.72	7.49	62.65	.....	.....	.....	23,806.26
Cascade	.....	235.59	.....	205.54	.....	.....	0.58	441.71
Deer Lodge	30.28	32,498.76	.....	.....	.....	.....	.....	32,529.04
Fergus	.....	25,307.28	.....	.....	.....	.....	.....	25,307.28
Granite	1,438.62	3,720.97	63.13	23.36	.....	.....	.....	5,246.08
Jefferson	149.72	2,878.57	90.65	659.20	41.99	.....	3.24	3,823.37
Lewis and Clark	402.00	5,045.18	.10	378.57	.....	.....	.....	5,825.85
Lincoln	1.79	.....	.....	.....	.....	.....	.....	1.79
Madison	40,446.19	13,201.84	1.27	431.53	.....	.....	.....	54,080.83
Meagher	9.00	.....	.....	.....	.....	.....	.....	9.00
Missoula	1,023.33	860.58	.29	.....	.....	.....	.....	1,884.20
Park	42.96	.....	.....	.....	.....	.....	.....	42.96
Powell	1,223.98	338.05	494.05	139.27	.....	.....	.....	2,195.35
Ravalli	302.83	.48	.....	.24	.....	.....	.....	303.55
Sanders	38.41	.....	.....	.....	.....	3.29	.....	41.70
Silver Bow	173.62	2,270.04	24,759.63	6.63	.....	3.34	4,577.63	31,790.89
Total	45,579.75	[a]121,599.07	25,422.61	1,972.44	41.99	6.63	4,581.45	199,203.94

[a] Includes 116,964.96 ounces from gold ore, 451.46 ounces from gold and silver ore, and 4,182.65 ounces from silver ore.

SILVER.

The mine production of silver in Montana in 1914 was unsatisfactory, the decline relegating the State to fourth place among silver-producing States. Labor troubles and the curtailment in production of copper led to a decrease from 13,819,201 ounces, valued at $8,346,797, in 1913 to 12,016,460 ounces, valued at $6,645,102, in 1914, a decrease of 1,802,741 ounces. Sixty-six per cent of the silver, or 8,015,694 ounces, was contained in the copper ores, which averaged 1.84 ounces per ton. The largest increase in silver was in Madison, Beaverhead, and Deer Lodge counties. Dry or siliceous ores yielded 1,249,555 ounces, or 10 per cent of the total. Cyanidation and amalgamation mills produced precipitates and bullion containing 130,601 ounces of silver, concentration mills produced concentrates containing 8,356,411 ounces, and crude ore shipped to smelters contained 3,522,407 ounces.

Source of mine production of silver in Montana, by kinds of ore, in 1914, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Beaverhead	12	7,876	1,369	79,661	.....	.....	.....	88,918
Blaine	.....	31,496	.....	.....	.....	.....	.....	31,496
Broadwater	28	11,129	623	2,420	.....	.....	.....	14,200
Cascade	.....	19,045	.....	125,073	.....	.....	355	144,473
Deer Lodge	3	34,741	.....	.....	.....	.....	.....	34,744
Fergus	.....	5,716	.....	.....	.....	.....	.....	5,716
Granite	437	647,694	11,984	52,142	.....	.....	.....	712,257
Jefferson	29	21,902	4,099	51,155	48,373	.....	300	125,858
Lewis and Clark	80	18,485	21	41,270	.....	.....	.....	59,856
Madison	6,149	168,663	186	5,373	.....	.....	.....	180,371
Meagher	2	.....	3	.....	.....	.....	.....	5
Missoula	39	367	130	14,221	.....	.....	23,542	38,299
Park	4	.....	.....	.....	.....	.....	.....	4
Powell	183	4,488	47,331	12,438	.....	.....	.....	64,440
Ravalli	20	620	.....	600	.....	.....	.....	1,240
Sanders	4	.....	.....	.....	.....	3,547	.....	3,551
Silver Bow	51	277,333	7,949,948	3,841	.....	1,724	2,278,135	10,511,032
Total	7,041	[a] 1,249,555	8,015,694	388,194	48,373	5,271	2,302,332	12,016,460

[a] Includes 271,431 ounces from gold ore, 25,078 ounces from gold and silver ore, and 953,046 ounces from silver ore.

COPPER.

The mine production of copper from Montana ores sold or treated decreased from 287,828,699 pounds, valued at $44,613,448, in 1913, to 233,229,640 pounds, valued at $31,019,542, in 1914, a decrease of 54,599,059 pounds in quantity and of $13,593,906 in value. Silver Bow County, or practically the Butte district, contributed all the copper except 1,041,012 pounds. Broadwater County mines produced the next largest quantity, or 484,977 pounds, followed in order by Deer Lodge and Granite counties. Crude ore of various kinds smelted in 1914 contained 58,953,911 pounds of copper, or an average of 4.21 per cent. The sulphide copper ore of smelting grade predominated and contained 58,039,824 pounds, an average of 5.07 per cent, and the oxidized copper ores contained 128,462 pounds, or 9.39 per cent. Copper precipitates produced from mine waters and the washings from old tailings contained 5,216,782 pounds, against 8,365,202 pounds in 1913. Concentrates shipped to smelters contained 167,777,573 pounds, the bulk of which was from copper concentrates, which averaged 6.37 per cent. The output of copper from the Summit Valley or Butte district decreased from 285,649,058 pounds in 1913 to 232,175,254 pounds in 1914. Mining in Montana was unusually active up to August, 1914. At that time there were 13,300 men working in and about the mines of Butte. A number of the old mines were reopened and developed. The war, however, as in other sections of the country, had a demoralizing effect on the production of copper. In consequence, a 50 per cent reduction in production by the Anaconda and the North Butte companies went into effect at once and continued for the remainder of the year. The Great Falls smelter closed, and operations were practically suspended at the Pittsmont smelter of the East Butte Co.

Source of mine production of copper in Montana, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	1,297	55,206	2,446	.....	.....	58,949
Broadwater	461,395	23,188	394	.....	.....	484,977
Cascade	884	.....	2,675	.....	62	3,621
Deer Lodge	160,611	.....	.....	.....	.....	160,611
Granite	25,612	64,797	.....	.....	.....	90,409
Jefferson	28,669	36,427	363	.....	174	65,633
Lewis and Clark	1,281	5,826	9,060	.....	.....	16,167
Madison	10,424	24,742	1,052	.....	.....	36,218
Meagher	.....	2,654	.....	.....	.....	2,654
Missoula	199	24,337	.....	.....	.....	24,536
Powell	301	69,257	8,828	.....	.....	78,386
Ravalli	564	.....	.....	.....	.....	564
Sanders	.....	.....	.....	18,287	.....	18,287
Silver Bow	51,650	230,712,675	785	3,928	1,419,590	232,188,628
Total	[a] 742,887	231,019,109	25,603	22,215	1,419,826	233,229,640

[a] Includes 663,829 pounds from gold ore, 2,649 pounds from gold and silver ore, and 76,409 pounds from silver ore.

LEAD.

The mine production of lead in Montana was 9,656,008 pounds, valued at $376,584, in 1914, against 10,935,827 pounds, valued at $481,176, in 1913. Of this output, 56 per cent was derived from mines in Silver Bow County, which produced 5,386,356 pounds against 4,542,225 pounds in 1913. This increase was due largely to the output of lead in lead-zinc ores, which were concentrated. The next largest output of lead, or 1,583,041 pounds, came from Cascade County mines, followed by Lewis and Clark County, with 804,511 pounds. Crude ore shipped to the smelters contained about 25 per cent of the total lead, or 2,446,061 pounds, and the remainder, 7,209,947 pounds, was contained in concentrates. The lead ore shipped to smelters contained 2,314,073 pounds of lead, or an average of 16.27 per cent, and the copper-lead ore contained 78,147 pounds, or an average of 23.26 per cent. According to the Butte & Superior printed report, 2,972 tons of lead concentrate, containing 2,759,521 pounds of lead, were shipped. The zinc concentrate also contained 2.43 per cent lead, but part of that is lost.

Source of mine production of lead in Montana, by kinds of ore, in 1914, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	5,061	.....	516,765	.....	.....	521,826
Broadwater	632	.....	31,620	.....	.....	32,252
Cascade	6,212	.....	1,570,024	.....	6,805	1,583,041
Granite	.....	1,909	123,910	.....	.....	125,819
Jefferson	18,237	.....	438,855	.....	4,852	461,944
Lewis and Clark	420	.....	804,091	.....	.....	804,511
Madison	9,408	.....	140,857	.....	.....	150,265
Missoula	.....	.....	145,524	.....	295,716	441,240
Powell	.....	11,962	69,755	.....	.....	81,717
Ravalli	.....	.....	8,355	.....	.....	8,355
Sanders	.....	.....	.....	58,682	.....	58,682
Silver Bow	.....	.....	29,645	19,465	5,337,246	5,386,356
Total	[a] 39,970	13,871	3,879,401	78,147	5,644,619	9,656,008

[a] Includes 19,501 pounds from gold ore, 4,166 pounds from gold and silver ore, and 16,303 pounds from silver ore.

ZINC.

The mine production of zinc (calculated as spelter) in Montana was 111,580,544 pounds, valued at $5,690,608, in 1914, as against 88,673,083 pounds, valued at $4,965,693, in 1913. The bulk of the zinc output was from Silver Bow County and lesser quantities were from Jefferson, Missoula, Meagher, and Cascade counties. From the Butte & Superior ore mined at Butte the largest quantity of zinc was produced, amounting to 107,828,679 gross pounds, from concentrates having an average zinc content of 53.1642 per cent.

The Anaconda Copper Mining Co. is cleaning up and unwatering the Lexington mine,[1] formerly the property of the La France Copper Co., preparatory to exploring and mining large deposits of zinc ore in the property. At first, liberal tests will be made to determine the best method of treatment, and the ore will then be handled in the new water floatation plant being built at the Washoe smelter. The Anaconda Co. acquired the Lexington group of mines after the bankruptcy of the La France Copper Co. It has also begun work in the old Alice mines for the purpose of mining its extensive zinc and silver ores. The indications are that the company is going extensively into zinc mining.

It is expected that the zinc output will be much greater in 1915 on account of the ability of the Butte & Superior Co. to negotiate a new contract with another smelting company for the treatment of that portion of the output which could not be handled by the first contractors. This additional product[2] is expected to bring the output of Butte & Superior up to approximately 11,000 or 12,000 tons of zinc concentrate per month, which will be treated at the two smelters at Caney and Dearing, Kans. Under this contract an entirely new method of marketing the product of zinc mines has been adopted. A fixed treatment charge will be paid for smelting the ore and the product will be sold by or for the Butte & Superior Co. direct to the consumer.

Source of mine production of zinc in Montana, by kinds of ore, in 1914, by counties, in pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Cascade	.....	1,870	1,870
Jefferson	1,920,387	2,899	1,923,286
Meagher	12,308	.....	12,308
Missoula	.....	100,538	100,538
Silver Bow	.....	109,542,542	109,542,542
Total	1,932,695	109,647,849	111,580,544

MINING INDUSTRY IN MONTANA IN 1914.

During the first five months of the year 1914 conditions were good for a production of metal exceeding the normal output, but on June 12 a labor disturbance occurred at Butte without warning and seriously affected operations of the mining companies. The local authorities were unable to cope with the situation, and on September 1 the State militia was ordered to Butte, and the city was placed under martial law. The troops were withdrawn on November 12, 1914.

[1] Boston News Letter, Apr. 19, 1915.
[2] Butte & Superior Copper Co. (Ltd.) Ann. Rept. for year ending Dec. 31, 1914.

The decline in the demand for copper following the outbreak of the European war caused the smelter at Great Falls and a number of mines and one smelter at Butte to close. The output of copper from the Washoe plant at Anaconda was lessened to such an extent that for the remainder of the year only about 50 per cent of the normal production of the active mines was maintained. The European war had the opposite effect on the production of zinc in the Butte district, and preparations were made to dispose of double the former output. One company [1] based its future plans on the condition of the American zinc industry at the opening of the conflict abroad.

A plan of the Helena Mining Bureau whereby worthy mining properties are brought to the attention of the investing public attracted considerable attention in 1914 and is of far-reaching importance if carried out successfully. The bureau receives lists of mining properties, in which investment can be made by purchase or otherwise, and is prepared to furnish full information concerning location and developments.

Considerable attention has been given to the possibility of making acid phosphate at Anaconda. Some development work has been done on phosphate beds located in Montana, but no definite results have yet been obtained. Sulphuric acid for this work will be available from the new acid plant now nearing completion at the Washoe smelter.

METALLURGICAL INDUSTRY.

Altogether 44 milling plants of various kinds were operated in Montana during part or the whole of the year 1914; some of them were operated only for short periods. Twelve plants used the amalgamation process; 5 used amalgamation and concentration; 1 used amalgamation and cyanidation; 12 were straight cyanidation mills; 11 were straight concentration mills, of which 5 used oil flotation as part of the equipment; 1 used concentration and cyanidation; 1 was a copper leaching plant; and 1 was a copper precipitating plant which extracted copper from mine waters. There were several additional precipitating plants operated by lessees, whose output was included with that of the company from which they lease. Of the 216,621 tons of ore treated at gold and silver mills, 29,983 tons were treated by amalgamation and yielded 3,864.99 ounces of gold and 1,642 ounces of silver, or an average recovery of $2.66 in gold and 0.05 ounce of silver per ton. The ore treated by cyanidation aggregated 186,638 tons, which, with 5,597 tons of old tailings, yielded 35,775.66 ounces of gold and 128,959 ounces of silver, or an average recovery for ore and tailings of $3.85 in gold and 0.67 ounce of silver per ton. The total value of the bullion recovered from ore and old tailings by both amalgamation and cyanidation was $891,666, as against the output in 1913 amounting to $858,883. During 1914 there were 408 pounds of mercury, 45,583 pounds of potassium cyanide, and 106,155 pounds of sodium cyanide consumed in gold and silver mills. This represented 0.074 pound of mercury per ounce of gold and silver bullion and 0.013 pound per ton of ore treated. The consumption of cyanide was 0.921 pound per ounce of gold and silver bullion and 0.789 pound per ton of ore and tailings treated.

[1] Butte & Superior Copper Co. (Ltd.) Ann Rept. for year ending Dec. 31, 1914.

Quantity of ore to gold and silver mills, by processes, with quantity of gold and silver recovered in bullion produced in Montana in 1914, by counties.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Blaine	118,762			[a] 11,408.91	[a] 31,496	$253,260
Broadwater	64	233.06	69	.57	31	4,887
Cascade	5	3.51				72
Deer Lodge	10			7.36	9	157
Fergus	51,843			20,629.86	1,796	427,450
Granite	44	46.79	3	1.93	27	1,024
Jefferson	13	16.60	29			359
Lewis and Clark	[b] 20,217	2,213.97	1,186	[c] 1,191.57	[c] 7,625	75,271
Madison	[d] 22,379	995.93	334	[e] 1,985.00	[e] 87,800	110,359
Missoula	3,230	308.68	8	550.00	50	17,782
Powell	31	28.86	3			599
Silver Bow	23	17.59	10	.45	122	446
Total	216,621	3,864.99	1,642	35,775.65	128,959	891,666

[a] Includes bullion from 2,397 tons of old tailings.
[b] Also yielded 19 tons of concentrates.
[c] Includes bullion from 2,000 tons of old tailings.
[d] Also yielded 914 tons of concentrates.
[e] Includes bullion from 1,200 tons of old tailings.

Good results were reported from the experimental work carried on on a large scale in 1914 at the Washoe works [1] near Anaconda. The company's annual report says:

The round-table plant was completed as anticipated early in the year and was operated most successfully during the entire year; the results obtained exceeded all expectations not only as to percentage of recovery obtained but also as to the copper content of the concentrate. Work upon the 2,000-ton leaching plant was carried on without cessation, and it is expected that it will be in full operation about May, 1915, treating the sand tailings which have accumulated from the operations of previous years, amounting to many millions of tons. This plant when operating will produce about 700,000 pounds of copper per month at a very low cost. The 100-ton acid plant, upon which work was carried on continuously throughout 1914, will be ready for operation about May, 1915; the greater portion of its product will be used in the 2,000-ton leaching plant.

Exhaustive tests on a large scale were made during the past year on different methods of flotation, with success, and during the year 1915 the entire plan of the concentrator will be changed. The crushing capacity will be increased, and a method of flotation will be installed whereby all first and second class ores will be concentrated and the tonnage of the concentrator increased from its present capacity of 12,500 tons to that of 15,000 tons per day. It is expected that these improvements when completed will effect a saving of over 90 per cent of the copper content of the ores sent to Anaconda, compared with a 78 per cent saving as at present made. The increased saving will have a collateral advantage in that it will make available in the mines a large tonnage of low-grade ore which under present conditions can not be mined and treated at a profit.

The chlorination plant of the Northwestern Metals Co., near Helena, did not operate in 1914 except possibly for a few tests. The leaching plant of the Butte-Duluth Co.,[2] at Butte, was entirely remodeled during 1914, so as to give it a capacity of 1,000 tons of ore per day. From the new rock house the ore goes to large Dorr classifiers used for leaching, which deliver the tailings by a belt conveyor to the dump.

[1] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[2] Simons, Theodore, Mining in Montana in 1914; Eng. and Min. Jour., Jan. 9, 1915.

The copper-bearing solutions go to 64 electrolytic cells, which extract the bulk of the copper. The last wash water passes to an iron precipitating plant making copper. The Timber Butte mill for concentration of zinc ores using flotation in their treatment was placed in operation in June, 1914. It was built for a capacity of 350 to 400 tons per day to treat Elm Orlu zinc ores. These ores assay 20 per cent of zinc, 0.8 per cent of copper, 1.5 to 2.5 per cent of lead, 7 ounces of silver, and 20 to 80 cents in gold per ton. The process of treatment is a combination of gravity and flotation concentration. The mill is arranged for two stages of table concentration and flotation with the re-treatment of lead-iron-zinc middlings on tables and jigs. This re-treatment is for the purpose of separating the lead and portions of the iron from the zinc. The coarse flotation concentrates are also re-treated over tables to take out additional iron and lead. The plant at the close of 1914 was producing about 110 tons of finished zinc concentrates daily and also lead-iron concentrates.

Mills equipped for the concentration of low-grade ore in the State treated 4,140,039 tons, or more than 80 per cent of the total ore mined. The concentrates produced and smelted amounted to 1,439,076 tons, containing 26,770.72 ounces of gold, 8,356,411 ounces of silver, 167,777,573 pounds of copper, 7,209,947 pounds of lead, and 111,568,236 pounds of zinc, valued in all at $33,460,080, or an average value of $23.25 per ton.

The following tables give the quantity of material shipped from the concentration mills and of crude ore shipped to the smelters, with the metal produced by counties in 1914, also the kind of concentrate and the average metallic content in each kind, during the period from 1911 to 1914, inclusive:

Mine production of gold, silver, copper, lead, and zinc, from Montana concentrates in 1914.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaverhead	16,800	1,196	65.45	79,661	2,446	516,765	.....	$65,885
Cascade	5,462	2,188	98.60	56,121	62	1,017,566	1,870	72,861
Jefferson	30	2,140	45.24	48,673	174	4,852	1,923,286	126,151
Lewis and Clark	.....	19	33.55	40	218	.....	.....	745
Madison	380	980	3,619.02	56,594	2,416	37,802	.....	107,904
Missoula	8,257	444	.....	23,542	.....	295,716	100,538	29,679
Silver Bow	4,110,010	1,432,109	22,908.86	8,091,780	167,772,257	5,337,246	109,542,542	33,056,855
Total	4,140,939	1,439,076	26,770.72	8,356,411	167,777,573	7,209,947	111,568,236	33,460,080

By kinds of concentrates.

Dry or siliceous	958	3,642.81	55,736	2,001	.....	.....	106,392
Copper	1,305,976	18,331.24	5,813,645	166,352,667	.....	.....	25,718,791
Lead	6,877	396.05	281,231	25,383	4,710,036	.....	350,775
Zinc	125,124	4,400.62	2,203,323	1,397,522	2,470,925	111,467,698	7,276,495
Lead-zinc	141	.....	2,476	.....	28,986	100,538	7,627

Kinds of concentrates and average metallic content of each kind produced in Montana in 1911–1914.

Kind and source of concentrates.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:							
Gold and silver mills—	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	1,436	$68.29	24.10	0.38	.....	.....	$82.02
1912	1,000	92.62	14.81	.33	0.53	.....	103.30
1913	831	44.75	35.46	.14	.....	.....	66.61
1914	933	80.22	59.73	.11	.....	.....	113.54
Concentration mills—							
1912	663	3.93	91.66	.26	7.99	.....	68.34
1913	14	29.93	32.21	1.37	.....	.....	53.64
1914	25	18.20	.40	.....	.....	.....	18.44
Copper:							
Concentration mills—							
1911	1,255,572	.38	5.62	7.69	.....	.....	22.58
1912	1,496,476	.36	5.37	7.30	.....	.....	27.75
1913	1,421,566	.35	5.14	7.21	.....	.....	25.82
1914	1,305,976	.29	4.45	6.37	.....	.....	19.69
Lead:							
Concentration mills—							
1911	2,485	4.01	66.48	.18	25.88	.....	62.99
1912	3,436	3.99	24.83	.08	39.02	.....	54.66
1913	5,985	1.27	38.47	.23	36.56	.....	57.39
1914	6,877	1.19	40.88	.18	34.24	.....	51.01
Gold and silver mills—							
1911	21	34.81	7.57	.75	10.35	.....	50.00
1913	86	32.41	7.82	.51	7.70	.....	45.47
Zinc:							
Concentration mills—							
1911	61,165	.28	8.03	1.09	.69	35.75	48.65
1912	32,947	.69	12.22	.35	1.87	40.66	67.16
1913	105,524	.60	14.52	.28	1.26	41.98	58.34
1914	125,124	.73	17.61	.56	.99	44.54	58.15
Lead-zinc:							
Concentration mills—							
1914	141	.....	17.56	.....	10.28	35.65	54.09

Mine production of gold, silver, copper, lead, and zinc, from Montana crude ore shipped to smelters in 1914.

By counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaverhead	512	299.10	9,245	56,503	5,061	.....	$19,007
Broadwater	27,141	23,376.23	14,069	484,977	32,252	.....	556,769
Cascade	1,825	339.60	88,352	3,559	565,475	.....	78,406
Deer Lodge	56,111	32,491.40	34,732	160,611	.....	.....	712,224
Fergus	982	4,677.42	3,920	.....	.....	.....	98,859
Granite	15,353	3,758.74	711,790	90,409	125,819	.....	488,253
Jefferson	6,908	3,611.81	77,127	65,459	457,092	.....	143,847
Lewis and Clarke	3,131	1,984.77	50,925	15,949	804,511	.....	102,687
Madison	3,253	7,034.69	29,494	33,802	112,463	.....	170,611
Meagher	26	.....	3	2,654	.....	12,308	983
Missoula	371	2.19	14,660	24,536	145,524	.....	17,090
Powell	1,823	942.50	64,254	78,386	81,717	.....	68,627
Ravalli	39	.72	1,220	564	8,355	.....	1,091
Sanders	122	3.29	3,547	18,287	58,682	.....	6,751
Silver Bow	582,501	8,690.37	2,419,069	57,918,215	49,110	.....	9,222,430
Total	700,098	87,212.83	3,522,407	58,953,911	2,446,061	12,308	11,687,635

By kinds of ore.

Dry or siliceous	119,767	78,315.62	1,063,218	740,886	39,970	.....	2,306,985
Copper	573,032	7,091.37	2,202,049	58,168,286	13,871	.....	9,101,248
Lead	7,111	1,799.20	251,869	22,524	2,314,073	.....	269,719
Zinc	20	.....	.....	.....	.....	12,308	628
Copper-lead	168	6.64	5,271	22,215	78,147	.....	9,055

Crude ore, by kinds, and average metallic content of each kind, produced in Montana and shipped to smelters, 1911–1914.

Kind of crude ore.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ozs. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	72,135	$14.54	18.16	0.19	0.95	.....	$25.50
1912	76,648	11.82	15.28	.69	.33	.....	23.79
1913	103,185	10.37	11.81	.33	.08	.....	18.59
1914	119,767	13.52	8.88	.31	.02	.....	19.26
Copper:							
1911	566,044	.30	4.48	6.43	.....	.....	18.75
1912	753,381	.22	3.46	5.54	.....	.....	20.63
1913	692,701	.23	4.34	5.22	.....	.....	19.03
1914	573,032	.26	3.84	5.08	.....	.....	15.88
Lead:							
1911	6,419	7.81	25.99	.27	16.46	.....	36.95
1912	7,380	4.25	24.48	.29	14.75	.....	33.54
1913	14,697	2.73	26.25	.30	11.65	.....	29.75
1914	7,111	5.23	35.42	.16	16.27	.....	37.93
Zinc:							
1912	95	.....	.....	.....	.....	37.26	51.42
1913	128	.97	28.64	.....	.....	30.17	52.06
1914	20	.....	.....	.....	.....	30.77	31.40
Copper-lead:							
1911	1,177	.86	77.30	4.43	33.57	.....	83.11
1912	1,788	1.18	45.13	3.30	19.02	.....	56.95
1913	1,054	.64	13.81	3.04	13.44	.....	30.24
1914	168	.81	31.38	6.61	23.26	.....	53.90
Lead-zinc:							
1911	128	.....	.....	.....	6.81	29.69	39.98
1912	91	.....	31.26	.....	21.93	30.51	81.07

Four smelters were in operation in Montana up to the time of the beginning of hostilities abroad, when two copper plants closed and another, the Washoe, cut its production of copper to 50 per cent of its normal output. The lead plant at East Helena operated throughout the year at its normal capacity of 15,000 tons per month, 10,000 tons of which was lead ore from the Coeur d'Alene district in Idaho. Two additional Dwight Lloyd sintering machines installed during 1914 are said to have increased the roasting capacity by 250 tons per day. At the Washoe works the first reverberatory fired by coal dust was started in September. During that month it smelted 475 tons of ore daily with a coal consumption of 13.8 per cent, against 260 tons and 24.1 per cent consumption of coal in the natural-draft coal-fired furnaces. This was such a success [1] that the entire reverberatory plant will be remodeled and operated with pulverized coal as fuel. The following is from the Anaconda Copper Co.'s annual report:

The remodeled furnaces will have a hearth area 144 feet in length and 25 feet in width. The benefits which it is expected will be derived from this change of practice will very materially affect the cost of production, as a much heavier tonnage of charge per furnace will be treated, with a much decreased coal ratio than heretofore. It is planned to maintain the blast-furnace department in its present excellent condition, but not to operate the same, using it only in case of emergency, or as an element to lend greater elasticity to the copper-producing power of the smeltery. A new roaster plant will be installed consisting of 40 furnaces, each 25 feet in diameter.

The entire converter department will be equipped with converters of the Great Falls type, cylindrical in shape and 20 feet in diameter. In connection with this department and under the same roof a reverberatory furnace will be built 175 feet in length and 25 feet in width, which will be used for cleaning the converter slag.

Construction work at Great Falls was retarded during the latter part of the year by the shutdown, but is under full headway at the present time. There has been in

[1] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

operation at Great Falls for many years an electrolytic refinery with a capacity of 5,000,000 pounds of copper per month, which has become antiquated and no longer economical to operate, and it is proposed to build upon an adjoining site an electrolytic refinery having a capacity of 10,000,000 pounds of copper per month. * * *

It is planned here as at the Washoe plant to abandon blast-furnace practice and to treat in coal-dust fired reverberatories the concentrates shipped from Anaconda. The new reverberatory furnaces will be completed during the year 1915.

A classification of kinds of crude ore shipped to the smelters, separated into oxidized and sulphides with average content, is shown in the two following tables:

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Montana and shipped to smelters in 1914.

Kind of ore.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous ore	119,767	78,315.62	1,063,218	740,886	39,970	.....	$2,306,985
Copper:							
Oxidized	684	21.08	2,192	128,462	.....	.....	18,733
Sulphide	572,348	7,070.29	2,199,857	58,039,824	13,871	.....	9,082,515
Lead:							
Oxidized	3,147	1,078.90	101,463	1,919	612,413	.....	102,551
Sulphide	3,964	720.30	150,406	20,605	1,701,660	.....	167,168
Zinc:							
Oxidized	20	.....	.....	.....	.....	12,308	628
Copper-lead:							
Sulphide	168	6.64	5,271	22,215	78,147	.....	9,055
Total	700,098	87,212.83	3,522,407	58,953,911	2,446,061	12,308	11,687,635

Oxidized and sulphide crude ores, average metallic content, by kinds, produced in Montana and shipped to smelters in 1914, compared with 1913.

Kind of ore.	Quantity.	Average metallic content.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1913	103,185	0.50	11.81	0.33	0.08	.....	$18.59
1914	119,767	.65	8.88	.31	.02	.....	19.26
Copper:							
Oxidized—							
1913	21,881	.01	.46	4.01	.....	.....	12.97
1914	684	.03	3.20	9.39	.....	.....	27.39
Sulphide—							
1913	670,820	.01	4.46	5.25	.....	.....	19.23
1914	572,348	.03	3.84	5.07	.....	.....	15.87
Lead:							
Oxidized—							
1913	3,987	.20	17.67	.....	11.44	.....	24.95
1914	3,147	.34	32.24	.03	9.73	.....	32.59
Sulphide—							
1913	10,710	.10	29.44	.40	11.77	.....	31.54
1914	3,964	.18	37.94	.26	21.46	.....	42.17
Zinc:							
Oxidized—							
1913	77	.....	.....	.....	.....	32.47	36.36
1914	20	.....	.....	.....	.....	30.77	31.40
Sulphide—							
1913	51	.12	71.90	.....	.....	26.71	75.76
Copper-lead:							
Oxidized—							
1913	12	.73	13.43	4.05	13.75	.....	47.83
Sulphide—							
1913	1,042	.02	13.81	3.03	13.44	.....	30.03
1914	168	.04	31.38	6.61	23.26	.....	53.90
Total—							
1913	811,765	.08	5.70	4.50	.24	.004	19.18
1914	700,098	.12	5.03	4.21	.17	.001	16.69

PRODUCTION BY COUNTIES.

GENERAL STATEMENT.

A table of the State output by counties in 1914, giving the mine production of each metal with the total value, follows; also a table showing production of ore and average value per ton by counties in 1913 and 1914, a table of the statistics of placer mines, and a review of the mining industry for each county and each producing mining district.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1914, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ozs.		*Fine ozs.*			*Fine ozs.*	
Beaverhead	100.62	$2,080	364.55	$7,536	$9,616	88,918	$49,172
Blaine			11,408.91	235,843	235,843	31,496	17,417
Broadwater	196.40	4,060	23,609.86	488,059	492,119	14,200	7,853
Cascade			441.71	9,131	9,131	144,473	79,894
Deer Lodge	30.28	626	32,498.76	671,809	672,435	34,744	19,213
Fergus			25,307.28	523,148	523,148	5,716	3,161
Granite	1,438.62	29,739	3,807.46	78,707	108,446	712,257	393,878
Jefferson	149.72	3,095	3,673.65	75,941	79,036	125,858	69,599
Lewis and Clark	402.00	8,310	5,423.85	112,121	120,431	59,856	33,100
Lincoln	1.79	37			37		
Madison	40,446.19	836,097	13,634.64	281,853	1,117,950	180,371	99,745
Meagher	9.00	186			186	5	3
Missoula	1,023.33	21,154	860.87	17,796	38,950	38,299	21,179
Park	42.96	888			888	4	2
Powell	1,223.98	25,302	971.37	20,080	45,382	64,440	35,635
Ravalli	302.83	6,260	.72	15	6,275	1,240	686
Sanders	38.41	794	3.29	68	862	3,551	1,964
Silver Bow	173.62	3,589	31,617.27	653,587	657,176	10,511,032	5,812,601
Total	45,579.75	942,217	153,624.19	3,175,694	4,117,911	12,016,460	6,645,102

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaverhead	58,949	$7,840	521,826	$20,351			$86,979
Blaine							253,260
Broadwater	484,977	64,502	32,252	1,258			565,732
Cascade	3,621	482	1,583,041	61,739	1,870	$95	151,311
Deer Lodge	160,611	21,361					713,009
Fergus							526,309
Granite	90,409	12,025	125,819	4,907			519,256
Jefferson	65,633	8,729	461,944	18,016	1,923,286	98,088	273,468
Lewis and Clark	16,167	2,150	804,511	31,376			187,057
Lincoln							37
Madison	36,218	4,817	150,265	5,860			1,228,372
Meagher	2,654	353			12,308	628	1,170
Missoula	24,536	3,263	441,240	17,208	100,538	5,127	85,727
Park							890
Powell	78,386	10,425	81,717	3,187			94,629
Ravalli	564	75	8,355	326			7,362
Sanders	18,287	2,432	58,682	2,288			7,546
Silver Bow	232,188,628	30,881,088	5,386,356	210,068	109,542,542	5,586,670	43,147,603
Total	233,229,640	31,019,542	9,656,008	376,584	111,580,544	5,690,608	47,849,747

Ore sold and treated, number of mines producing, and average value per ton of ores in Montana in 1913 and 1914, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1914	Increase (+) or decrease (−).	1913	1914	1913	1914	1913	1914
	Short tons.	*Short tons.*						
Beaverhead	17,312	+ 12,907	7	10	$17.11	$4.90	$11.96	$3.28
Blaine	121,159	+ 40,495	5	3	3.71	2.09	3.71	2.09
Broadwater	27,205	+ 9,073	31	19	23.91	20.65	20.36	18.23
Cascade	7,292	− 6,308	15	12	23.72	20.75	13.37	12.21
Deer Lodge	56,121	+ 22,855	4	8	8.90	12.69	8.46	12.31
Fergus	52,825	− 2,485	13	7	8.49	9.96	8.42	9.96
Granite	15,397	− 22,591	27	32	15.84	31.78	14.28	30.68
Jefferson	15,997	− 28,152	55	49	9.12	16.90	4.52	9.10
Lewis and Clark	25,348	− 29	52	42	6.79	7.05	6.33	5.73
Lincoln		− 125	2		28.42		20.77	
Madison	27,212	+ 9,964	105	90	13.98	14.29	13.08	13.90
Meagher	26	+ 21	1	2	41.40	37.81		.08
Missoula	11,858	− 1,978	7	7	4.89	5.44	2.24	3.28
Powell	1,854	− 323	18	13	37.06	37.34	27.42	30.00
Ravalli	39	− 27	3	2	22.92	28.00	8.82	17.69
Sanders	122	− 1,118	7	1	31.75	55.33	10.13	16.64
Silver Bow	4,749,189	− 863,341	78	61	10.26	9.08	1.45	1.36
Total	5,128,956	− 831,162	430	358	10.25	9.14	1.85	1.91

[a] Value per ton, placer product excluded.

Number of producing placer mines and production in Montana in 1913 and 1914, by counties.

County.	1913						1914					
	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver.	Total value.	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver.	Total value.
				Value.	*Fine ounces.*					*Value.*	*Fine ounces.*	
Beaverhead	7	....	....	$2,729	11	$2,736	7	....	....	$2,080	12	$2,087
Broadwater	9	....	1	3,555	24	3,569	10	....	....	4,060	28	4,076
Cascade	1	....	....	75	2	76	....	....	....	....	....	....
Deer Lodge	....	....	....	....	....	....	2	....	....	626	3	628
Granite	6	....	....	19,357	270	19,520	10	....	....	29,739	437	29,981
Jefferson	10	....	....	2,111	18	2,122	11	....	....	3,095	29	3,111
Lewis and Clark	15	1	2	23,672	191	23,787	30	....	1	8,310	80	8,354
Lincoln	1	....	....	101	....	101	1	....	....	37	....	37
Madison	15	1	....	691,651	4,880	694,598	12	1	....	836,097	6,149	839,497
Meagher	3	....	....	774	6	778	2	....	....	186	2	187
Missoula	21	....	....	14,527	33	14,547	19	1	....	21,154	39	21,176
Park	4	....	....	2,554	16	2,564	5	....	....	888	4	890
Powell	21	....	1	23,732	111	23,799	21	....	2	25,302	183	25,403
Ravalli	2	....	....	10,383	31	10,402	3	....	....	6,260	20	6,271
Sanders	1	....	....	570	3	572	3	....	....	794	4	796
Silver Bow	5	....	1	5,211	27	5,227	6	....	....	3,589	51	3,617
Total	121	2	5	801,002	5,623	804,398	142	2	3	942,217	7,041	946,111

PLACER MINING IN MONTANA.

According to the Director of the Mint [1] the first production of gold in Montana on a large scale was in 1862 by hydraulicking and other methods from the rich bars lying along Grasshopper Creek and tributary gulches in the central portion of Beaverhead County, both above

[1] Production of precious metals in the United States; Director of Mint Rept., 1897, p. 141.

and below the town of Bannock, and it amounted to not less than $600,000. This stimulated the pioneers to prospect the territory now comprised within the boundaries of Montana and resulted in the discovery of the millions of treasure in Alder, Last Chance, and Confederate gulches, and in the opening of many lesser "diggings" that have since added their output to the enormous total of gold and silver. No attempt has thus far been made to determine the total production of gold and silver to date from placer mining operations in Montana. However, figures have been collected for the production of placer gold recovered by dredging and other methods since 1896, inclusive, and these are shown in the following table:

Gold produced by dredging and other methods in Montana, 1896–1914.

Year.	Number of operating dredges.	Gold recovered by—			Year.	Number of operating dredges.	Gold recovered by—		
		Dredging.	Hydraulicking, sluicing, drifting.	Total.			Dredging.	Hydraulicking, sluicing, drifting.	Total.
1896	1	[a] $42,000	$625,099	[b] $667,099	1907	4	[c] $197,141	[c] $151,526	[c] $348,667
1897	4	[a] 102,120	588,710	[b] 690,830	1908	4	[c] 402,667	[c] 147,328	[c] 549,995
1898	4	[a] 154,838	499,683	[b] 654,521	1909	5	[c] 426,649	[c] 116,723	[c] 543,372
1899	5	[a] 165,440	430,480	[b] 595,920	1910	7	[c] 473,318	[c] 102,599	[c] 575,917
1900	5	[a] 189,665	362,463	[b] 552,128	1911	8	[c] 597,778	[c] 87,023	[c] 684,801
1901	5	[a] 146,134	376,566	[b] 522,700	1912	6	[c] 710,387	[c] 96,032	[c] 806,419
1902	7	[a] 318,914	128,132	[b] 447,046	1913	6	[c] 685,210	[c] 115,792	[c] 801,002
1903	4	[b] 229,332	[b] 252,115	[b] 481,447	1914	5	[c] 835,615	[c] 106,602	[c] 942,217
1904	2	[b] 245,700	[b] 232,865	[b] 478,565					
1905	5	[c] 275,542	[c] 121,359	[c] 396,901	Total		6,595,480	4,665,882	11,261,362
1906	4	[c] 397,030	[c] 124,785	[c] 521,815					

[a] Partly estimated. [b] Reported by Director of Mint. [c] U. S. Geol. Survey Mineral Resources.

Gold dredging of any magnitude was not commenced in Montana until 1896.[1] This was on Grasshopper Creek at Bannock, in Beaverhead County. The first operations in 1895, when the new era of placer mining dawned, were unprofitable, but by rebuilding and adding to the first equipment during the summer of 1896 a dredging plant was finally obtained that effected a profitable recovery of gold from the creek bed and the low-lying gravels. This first plant was the property of the Gold Dredging Co., of Chicago. Encouraged by its success, a second corporation known as the Bannack Dredge Co. was formed by members of the former company and others. This company secured ground and erected a second plant at the beginning of the 1897 season. The Chicago Mining & Developing Co., which had some time previously installed a suction dredge, remodeled it to a bucket dredge similar to that of the Gold Dredging Co; and, late in 1897, the Bon Accord Mines (Ltd.), an English corporation, installed a plant still further improved on its grounds some three miles below Bannock. These dredges [2] were of the floating type and were all successfully operated on Grasshopper Creek during 1897. Traction or land-mining machines were employed satisfactorily at Washington Gulch, Powell County, and in Alder Gulch, near Virginia City. The first steps to prove the area below Alder Gulch for machine

[1] Director Mint Rept., 1897, pp. 142, 173–178. [2] Idem, p. 173.

mining were taken in 1896. Explorations were made by test shafts and drilling with Keystone drills.

After various early attempts at dredging with orange-peel excavators and then with various types of steam dredges, in 1899 and 1902, and after the remodeling of these several times, the third dredge, built and starting in 1906, was electrically equipped. This plant proved so successful that it was decided to equip the other dredges in the same way, and they are operated now by power from the plant of the Madison River Power Co., in Madison Canyon, 50 miles east. Attempts have been made from time to time to operate other dredges of various kinds in different parts of Montana, but none of them have operated as steadily as those formerly at work in Beaverhead County and those which continue to operate in 1914 in Alder Gulch.

BEAVERHEAD COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Beaverhead County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1913	14	4,405	$26,741	47,489	65,681	284,175	$78,109
1914	17	17,312	9,616	88,918	58,949	521,826	86,979
Increase (+) or decrease (−) in 1914	.....	+12,907	−17,125	+41,429	−6,732	+237,651	+8,870

[a] Includes placer production.

Ten deep-mine operators reported the production of 17,312 tons of ore, which was 12,907 tons more than was mined by 7 producers in 1913. The total average value per ton decreased from $17.11 in 1913 to $4.90 in 1914, and the gold and silver value from $11.96 to $3.28 per ton. Milling plants concentrated 16,800 tons of ore producing lead concentrate carrying gold and silver and a little copper with an average value per ton of $55.09, which was shipped to the smelters, along with 512 tons of crude ore, containing $6,183 in gold, 9,245 ounces of silver, 56,503 pounds of copper, and 5,061 pounds of lead, valued in all at $19,007, or an average value per ton of $37.13. Lead ore predominated, all of which was of milling grade. There were also 264 tons of copper ore and 248 tons of dry or siliceous ore. Placer bullion produced contained $2,080 in gold and 12 ounces of silver, against a yield of $2,729 in gold and 11 ounces of silver in 1913.

Argenta district.—Two deep mine producers reported the shipment of 81 tons of ore to the smelter, containing copper, silver, and a little gold and averaging $32.46 per ton. The larger part of the shipments came from the Jack Rabbit claim, which produces a sulphide ore, and is opened by 200 feet of drifts.

Bannock district.—One deep mine and 4 placers reported gold, silver, and a small quantity of lead and copper, valued in all at $9,806. The output of ore was 214 tons and the placer bullion contained $1,396 in gold and 5 ounces of silver. The largest part of the production came from the Bannack Consolidated holdings. The ore was taken out in development work and by lessees.

Beaverhead or Bloody Dick district.—The Sunshine property produced a small quantity of copper ore containing some gold and silver. This claim is opened by a shaft 60 feet deep. Shipments of copper oxidized ore were also made from the Saginaw property, near Jackson. Developments on this property consist of an incline shaft 300 feet deep and 300 feet of drifts.

Big Hole district.—According to reports it is estimated that $612 in gold and 7 ounces of silver were produced from the placers in the district. No shipments were recorded from deep mines.

Blue Wing district.—A small shipment of silver ore containing copper and a little gold was made by lessees from one property in the district.

Bryant district.—One producer, the Penobscot Mining Co., reported the output of lead-silver ore, all of which was milled at the Hecla plant and produced concentrates.

Pioneer district.—Placer deposits of stream and bench gravel situated on Calf Creek were worked during two months of 1914 by the sluicing and rocking methods, and produced a small quantity of gold and silver.

Polaris district.—Lessees shipped a small quantity of silver ore containing gold and a small quantity of copper. The property is opened by an incline shaft 50 feet deep.

Utopia district.—The Indian Queen mine and its 40-ton smelting plant were not operated in 1914. A small shipment of ore, containing copper and a little silver and gold, probably from dump material, was reported from one property in the district. Included in the output of the district is a small quantity of gold ore from the Butte & Vipond property, containing a little silver and a trace of copper.

BLAINE COUNTY.

Three producers in 1914 reported 118,762 tons of ore and 2,397 tons of old tailings treated by cyanidation and yielding bullion valued at $253,260. The ore treated was 40,495 tons more than was produced in 1913 by 5 producers.

Little Rockies district.—Three deep mines produced ore of milling grade, and a small quantity of old tailings was re-treated by the cyanidation process. The largest producer was the Mint & Badge property of the Ruby Gulch Mining Co., which is equipped with a new cyanidation mill of 600 tons daily capacity, the old mill having been destroyed by fire in October, 1913. Treatment of ore was begun in September and continued during the remainder of the year. Similar ore was treated at the August 200-ton cyanidation plant. This plant was remodeled in 1914 for fine grinding and equipped with tube mills, a Trent agitator, a Dorr thickener, and Oliver filters. The property is opened by a tunnel and has one main shaft. The property had been idle since 1911. The Beaver Creek Co., operating the Ethel property, made a number of shipments of bullion recovered from cyanidation of the ores mined.

BROADWATER COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Broadwater County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	41	18,132	$365,522	12,101	398,791	55,281	$437,076
1914	29	27,205	492,119	14,200	484,977	32,252	565,732
Increase (+) or decrease (−) in 1914		+9,073	+126,597	+2,099	+86,186	−23,029	+128,656

[a] Includes placer production.

The output by 19 producers of ore in the county was 27,205 tons, or 9,073 tons more than was produced by 31 operators in 1913. The total average value per ton of ore decreased from $23.91 in 1913 to $20.65 in 1914, and the gold and silver value per ton from $20.36 to $18.23. As in previous years, the greatest part of the ore produced, or 27,141 tons, was of shipping grade and yielded $483,229 in gold, 14,069 ounces of silver, 484,977 pounds of copper, and 32,252 pounds of lead, valued in all at $556,769, or an average value per ton of $20.51. Only one lot of ore was reported as having been milled, and yielding gold and silver bullion. Placer bullion reported amounted to $4,060 in gold and 28 ounces of silver, against $3,555 in gold and 24 ounces of silver in 1913.

Backer or Diamond City district.—The principal part of the gold and silver produced in the district was from the Slim Jim claims, which produced a small quantity of free-milling gold ore that was treated in a 1-stamp mill. During the year the mill was rebuilt and improved. Some bullion was also reported from small placer operations.

Beaver Creek or Winston district.—Five deep-mine producers reported 117 tons of lead ore, all of shipping grade and containing $3,127 in gold, 2,591 ounces of silver, 28,254 pounds of lead, and a small quantity of copper, valued in all at $5,714, or an average value per ton of $48.84. The output of 1913 amounted to 480 tons, averaging $39.33 per ton. The ore was produced principally from the properties of the East Pacific Co. and the Custer Co. Small shipments were made from the Mary V., Molly, and Red Buck.

Cedar Plains or Radersburg district.—Seven deep-mine producers reported the output of 27,011 tons of ore, all of which, with the exception of 2 tons producing bullion, was shipped directly to the smelters and contained $479,686 in gold, 11,404 ounces of silver, and 484,583 pounds of copper, valued in all at $550,442, with an average value per ton of $20.38. This output of ore was an increase over that of 1913, which had a total value amounting to $407,900 and averaging $23.21 per ton. The principal producer was the Keating mine, whose output was iron sulphide ores bearing chiefly gold and a little silver and copper. The iron content in 1914 averaged from 20 to 30 per cent and the silica from 25 to 45 per cent. There are 17,400 feet of drifts and crosscuts which open the mine. Ac-

cording to the last annual report of the company [1] the main shaft was sunk from 800 feet to 1,200 feet and the 1,000-foot level was extended north of the shaft 1,160 feet. The following is from the company's annual report:

> The ore values in this level have been fully as good as they were in the 800, and the ore is a little wider. A station has recently been cut at the 1,150 that disclosed the vein with a ledge of sulphide ore carrying values in gold and copper a little better than the values at the shaft on the 800. There is one body of ore that is completely blocked out on four sides between the 800 and 1,000 that is 900 feet long and 200 high. Besides this ore there are many other large bodies exposed on two sides. The copper values seem to grow better with depth, while the gold values are fully as good as they were on the upper levels where there was no copper. In addition to the gold, the company is producing from 90,000 to 100,000 pounds of copper each month. There are on the dumps at the mine about 120,000 tons of concentrating ore of a gross value of $5 per ton that can be concentrated by installing a concentrator.

Ore similar to that of the Keating was shipped from the Black Friday, Copper King, and Ohio Keating mines. A small quantity of ore was reported to have been shipped from the May Day group of claims. This property is equipped with a 40-ton dry concentration mill.

Deep Creek district.—A small quantity of placer nuggets came from the Big W. & A. claims, most of which was sold to jewelry firms.

Park district.—The output of the district, amounting to $3,529 in gold, 144 ounces of silver, and 3,988 pounds of lead, valued in all at $3,765, came from 5 deep mines and 4 placers. Of the 59 tons produced, 44 tons were milled and yielded gold and silver bullion, and the remainder, consisting of sulphide ore containing lead with some gold and silver, was shipped directly to the smelter. The principal producers of lead ore were the Goodenough and the W. A. Clark properties. The placer production was from Indian Creek, where some ground was worked by hydraulic methods and a steam shovel was operated, a small output of gold being produced.

CASCADE COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Cascade County, Mont, in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	16	13,600	[a] $5,433	[a] 292,266	3,717	3,179,501	4,510	$322,689
1914	12	7,292	9,131	144,473	3,621	1,583,041	1,870	151,341
Increase (+) or decrease (−) in 1914		−6,308	+3,698	−147,793	−96	−1,596,460	−2,640	−171,348

[a] Includes placer production.

Twelve operators reported the production of 7,292 tons of ore, 6,308 tons less than was reported in 1913 by 15 producers. The total average value per ton of the ore decreased from $23.72 in 1913 to $20.75 in 1914, and the gold and silver value in this ore from $13.37 to $12.21 per ton. The larger part of the ore (5,462 tons) was concentrated into lead concentrate and a small quantity of zinc

[1] Published in Min. and Eng. World, June 5, 1915, p. 1049.

concentrate. Concentrates shipped to the smelters contained $2,038 in gold, 56,121 ounces of silver, 1,017,566 pounds of lead, and 1,870 pounds of zinc, valued in all at $72,861, or an average value of $33.30 per ton. In addition to the concentrates, there were shipped to smelters 1,825 tons of crude ore, which contained $7,021 in gold, 88,352 ounces of silver, 3,559 pounds of copper, and 565,475 pounds of lead, valued in all at $78,405, or an average value per ton of $42.96. The larger part of the ore mined (7,070 tons) was classified as lead ore. There were also 205 tons of dry or siliceous ore and 17 tons of lead-zinc ore.

Montana district.—The output of this district is practically that of the county. The concentrating ore came chiefly from the Barker mines and produced a lead concentrate. Much of the best ore was shipped directly to the East Helena smelter. The mines were closed in June, having operated 169 days during the year. Shipments of ore were also made from the Ripple, Liberty, Big Seven, Queen of the Hills, and Silver Bell properties.

DEER LODGE COUNTY.

In 1914 there were 56,121 tons of ore produced from 8 properties, 22,855 tons more than was produced at 4 properties in 1913. The total average value per ton of the ore increased from $8.90 in 1913 to $12.69 in 1914, and the gold and silver value per ton in this ore from $8.46 to $12.31. All the ore, with the exception of 10 tons, was of shipping grade, used chiefly in fluxing the charges at the smelters. The placer output amounted to $626 in gold and 3 ounces of silver.

Georgetown district.—Eight producers reported the shipment of 56,121 tons of ore, most of which was oxidized iron ore, carrying gold and valuable principally as flux for smelting. The largest part of the output was from the Southern Cross mine. The Oro Fino, Hold Fast, and Short Shift properties were also producers.

Heber district.—A small production of placer gold was reported by a bullion buyer to have come from the Dry Gulch section in 1914.

FERGUS COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Fergus County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	13	55,310	$459,713	9,939	1,073	17,457	49,999	$469,450
1914	7	52,825	523,148	5,716	.....	.....	.....	526,309
Increase (+) or decrease (−) in 1914	.....	−2,485	+63,435	−4,223	−1,073	−17,457	−49,999	+56,859

[a] Includes placer production.

Seven producers reported 52,825 tons of ore, 2,485 tons less than was reported by 13 producers in 1913. The total average value per ton of the ore increased from $8.49 in 1913 to $9.96 in 1914, and the gold and silver value from $8.42 to $9.96 per ton. The greater part was of milling grade and produced gold and silver bullion by cyani-

dation. Only 982 tons of ore, containing gold and silver, was shipped directly to smelters; it averaged $100.67 per ton.

North Moccasin district.—The North Moccasin property, owned by the Barnes-King Development Co., operated its 200-ton cyanide mill on siliceous gold ores, which produced considerable gold bullion containing a little silver. According to the annual statement of the Barnes-King Development Co.,[1] the North Moccasin mine produced 51,471 tons of ore, which was milled in its cyanidation mill and yielded 24,395.18 ounces of gold and silver bullion, for which the net value received amounted to $424,410.96. The mill operated 359 days and treated an average of 143.8 tons of ore per day, assaying $8.92 in gold and silver. The saving was reported to be 93 per cent. The consumption of cyanide was 0.27 pound per ton of ore; zinc, 0.46 pound per ton of ore; and lime, 3.24 pounds per ton of ore. The following extract is from the company's annual report:

> During the year 1914 mining and milling at the North Moccasin proceeded continuously. * * *
>
> There were no new discoveries of new ore bodies, but during the latter half of the year the extension in depth of the eastern ore shoot was picked up on the 600 level at a point 280 feet southeast of the bottom of the Santiago incline and proved for a distance of 25 feet vertically below the level, where the dip of the vein is quite flat.
>
> In this ore shoot black or unoxidized ore has been found more or less mixed with the oxidized all the way from the 400 level down, and since it can not be treated by cyanidation without first roasting it has caused much annoyance on account of the necessity of keeping it out of the mill ore. The tonnage of this black ore, roughly estimated at 7,000 tons, is now sufficient to make preparations for installing a small cylindrical type of roaster.

Warm Springs district.—Six producers reported the output of 1,354 tons of ore containing $98,620 in gold and 3,961 ounces of silver and having a total value of $100,810, or an average value per ton of $74.45. The greater part of the ore (982 tons) was of shipping grade, and the remainder was treated in cyanidation plants producing gold bullion containing silver. The principal producers were the Spotted Horse, Cumberland, Comeback, and Gold Reef claims. Some conditions existing in the Gold Hill section of the Warm Springs or Maiden district are reviewed in a recent publication,[2] as follows:

> The McGinnis group comprises five patented claims, with a 10-stamp mill and cyanide equipment. The mine was discovered in 1881 and worked in a crude way until 1899. During this period of operation the gold production was approximately $1,500,000. This mine was closed down in 1899 and not reopened until 1909. It was then operated in a small way for a period of three or four years, the small average force of seven men being employed taking out ore during this run.
>
> The production during this last period was $328,000, or an average of $100,000 per year. * * *
>
> The Spotted Horse mine is located on the most easterly of the porphyry sheets of the first intrusive period, and at the junction where it is sheared by the Gold Hill porphyry of the second intrusive period. The mine workings are 1,500 feet distant from the old workings of the McGinnis mine. The mine was discovered in 1881 and was operated in an indifferent way until 1902. During this period of operations the mine changed hands seven different times. Apparently each owner in his time was satisfied to do just sufficient development work to open up a new ore body, extract the ore in sight, and then sell the property. During the 20 years the mine was thus operated the production exceeded $5,000,000 in gold.
>
> In 1902 the property was closed down and remained closed for 10 years. In 1912 the mine again resumed operations, this time under the management of Coolidge, Bryant, and associates, and is still being operated by them.

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[1] Barnes-King Development Co. Ann. Rept. for year ending Dec. 31, 1914.

[2] Hoyt, B. F., Gold Hill section of Maiden district, Montana: Min. and Eng. World, Jan. 23, 1915, pp. 171–172.

During the past 20 months, with an average working force of 15 men, the mine has produced $200,000 in ore shipped and approximately $145,000 in ore broken down ready for milling. * * *

Four ore chimneys have been opened up at this juncture and worked to a depth of 585 feet. As yet no development has been attempted below this depth.

GRANITE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Granite County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	33	37,988	$121,297	729,777	362,366	70,832	$621,366
1914	42	15,397	108,446	712,257	90,409	125,819	519,256
Increase (+) or decrease (−) in 1914		−22,591	−12,851	−17,520	−271,957	+54,987	−102,110

[a] Includes placer production.

Thirty-two producers in 1914 reported 15,397 tons of ore, 22,591 tons less than was reported by 27 producers in 1913. The total average value per ton increased from $15.84 in 1913 to $31.78 in 1914, and the gold and silver value in this ore from $14.28 to $30.68 per ton. The ore shipped had a total value of $488,253. Only 44 tons of ore were reported treated at gold and silver mills. Ten placers produced $29,739 in gold and 437 ounces of silver, against $19,357 in gold and 270 ounces of silver from 6 placers in 1913.

Alps district.—The Rainy Day claim near Bonita was operated a short time during the year and produced a small quantity of gold bullion from the treatment of ore in an amalgamation plant of about 5 tons capacity.

First Chance district.—The ore produced in this district by 8 deep mines and amounting to 931 tons was shipped directly to the smelters and contained $35,235 in gold, 2,376 ounces of silver, and 4,228 pounds of copper, valued in all at $37,111, or an average value per ton of $39.86. Most of the ore was from the Magone and Anderson properties and ran high in gold. A considerable output was also reported from the properties operated by the First Chance Mining Co. A production was reported from 2 placers, amounting to $1,350 in gold and 6 ounces of silver, against a placer output in 1913 of $1,076 in gold and 6 ounces of silver.

Flint Creek district.—Fourteen deep mines produced 13,784 tons of ore of shipping grade, with the exception of less than 1 ton which was reported as a bullion test on a small quantity of ore. The ores mined contained $39,945 in gold, 697,624 ounces of silver, 52,101 pounds of copper, and 123,910 pounds of lead, valued in all at $437,494, or an average value per ton of $31.74. The largest part of the production, mostly siliceous silver ore and some of it partly oxidized iron ore, was from the Granite Bi-Metallic property. Mining on this property was confined to the drifts above water level and on what is called the south vein on the 1,000 and the 1,200 foot levels, which is below the water level. The property is opened by vertical shafts 1,800 feet deep and has several miles of drifts and adits. The milling plant on the property was not operated. Oxi-

dized and highly siliceous ores were also shipped from the Hope mine, which is equipped with a wet crushing mill of 12 stamps that has not been operated for 12 years. The vertical shaft on the property is 550 feet deep. Carbonate lead ore was shipped from the Torrit and the John Coyle claims, which averaged from 48 to 103 ounces of silver per ton with small values in gold. Silver ore containing a little copper and gold was shipped from the Hobo property. The Puritan was also a small producer. Placer gold was reported amounting to $349 in gold and 2 ounces of silver.

Red Lion district.—Oxidized iron ore was shipped from the Big Bull property. This property is opened by a 300-foot adit with inclines 150 and 200 feet deep. The property is near the Southern Cross mine, which is in Deer Lodge County.

Rock Creek district.—Two placers in the district produced gold bullion. One of the properties was operated by the Basin Mining Co. and the other, situated in Stingle Gulch, is known as the Gem No. 2 claim.

South Boulder district.—Ore amounting to 342 tons was mined, and, with the exception of 3 tons which produced a little bullion, was shipped directly to the smelters. The entire metallic output from this ore amounted to $1,382 in gold, 11,391 ounces of silver, 17,122 pounds of copper, and 1,909 pounds of lead, valued in all at $10,039, or an average value of $29.35 per ton. The principal producer was the Brooklyn property, from which sulphide copper ore containing silver was produced in cleaning out the old workings and sinking a winze 70 feet below the adit level. Smaller quantities of ore were shipped from the North Star property, where a concentration mill was under construction during 1914; from the Mount Powell property by lessees; and from the Fairview, Copper Queen, and Sunday properties.

JEFFERSON COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Jefferson County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	66	44,149	$64,136	227,764	874,164	1,519,768	10,501	$404,658
1914	60	15,997	79,036	125,858	65,633	461,944	1,923,286	273,468
Increase (+) or decrease(−)in 1914		−28,152	+14,900	−101,906	−808,531	−1,057,824	+1,912,785	−131,190

[a] Includes placer production.

Forty-nine producers in 1914 reported 15,997 tons of ore, 28,152 tons less than was reported by 55 producers in 1913. The total average value per ton increased from $9.12 in 1913 to $16.90 in 1914, and the gold and silver value in this ore from $4.52 to $9.10 per ton. Of the ore produced, 6,908 tons were shipped directly to the smelters and contained $74,663 in gold, 77,127 ounces of silver, 65,459 pounds of copper, and 457,092 pounds of lead, valued in all at $143,847, or an average value per ton of $20.82. A large quantity of old tailings was re-treated and produced zinc concentrates, which should properly

be credited to the Butte district, Silver Bow County, as the original ore was mined at Butte and hauled to Basin for treatment in previous years. There were only 13 tons of ore treated at gold and silver mills. Eleven placer operators reported a total production of $3,095 in gold and 29 ounces of silver, against 10 producers reporting $2,111 in gold and 18 ounces of silver in 1913.

Boulder district.—Three deep mines yielded 1,456 tons of ore, which contained $1,120 in gold, 29,373 ounces of silver, 9,801 pounds of copper, and 191,672 pounds of lead, valued in all at $26,141, or an average value per ton of $17.95. The larger part of the tonnage was lead oxidized ore carrying values in gold and a trace of copper. Some ore is reported to have been shipped from the Mammoth and the Blue Bird properties. The output of 3 placers amounted to $662 in gold and 9 ounces of silver.

Cataract (including Lowland) district.—Of the 994 tons of ore produced by 16 deep mines in the district, 964 tons was of shipping grade and 30 tons of milling grade. There was also a quantity of old tailings re-treated and producing zinc concentrate. The total output of the district, including the gold bullion from 3 placers, was valued at $154,084 for the content of gold, silver, copper, lead, and zinc. The largest part of the output came from milling the tailings of the Black Rock mine at Butte. The tailings were reground in a tube mill and oil flotation was used to recover the sulphides. Shipments of lead ore were made from the Corbett, East Rumley, Hattie Ferguson, Hennefy, Crystal & Comet, Bullion & Grey Eagle properties, and from the Ruby & Columbia property at Lowland, the last named producing some gold and silver bullion, probably from previous operations. The placer output amounted to $128 in gold and 3 ounces of silver from the gravel deposits hydraulicked near Cataract and in Overland and Rocker Creek gulches.

Colorado district.—The ore produced by 9 operators in the district was of shipping grade and amounted to 424 tons, containing $3,422 in gold, 5,450 ounces of silver, 6,741 pounds of copper, and 34,362 pounds of lead, valued in all at $8,673, or an average value per ton of $20.46. The greater part of the output was lead carbonate ore from the Mount Washington mine, which is opened by an incline shaft 300 feet deep and by 2,000 feet of drifts. Shipments of siliceous gold ore were made from the Peacock claim and of silver ore and some oxidized copper ore from the Portal claim. The Assets Gold mine produced siliceous gold ore, and the Alta-Gregory group a small quantity of gold-silver ore.

Elkhorn district.—Six producers reported 3,341 tons of ore, all of shipping grade and containing $32,695 in gold, 3,594 ounces of silver, 27,294 pounds of copper, and 12,701 pounds of lead, valued in all at $38,807, or an average value per ton of $11.62. Most of this ore, which was oxidized, proved valuable as an iron flux at the smelters and carried some gold, a little silver, and a trace of copper. The Swissmont and the Golden Currie groups were the principal producers of ore of this kind. Other producers in the district were the Mount Pleasant, Saracen, Black Diamond, and Albion claims.

Homestake district.—Two producers reported the output of 85 tons of ore, containing gold and silver. Some of the ore from the Hackensack claim was treated in an arrastre and produced gold and silver bullion. The Montana claim produced ore of shipping grade.

Lump Gulch districts.—Three deep mines and 2 placers reported production valued at $1,151. There were 27 tons of ore containing silver and some lead shipped from the district. The placer production amounted to $44 in gold.

McClellan district.—The Eliza property produced sulphide ore carrying gold and a little silver and copper. The claim is opened by a shaft 55 feet deep. There was also a small shipment of bullion from the Ophir placer.

Mitchell Gulch district.—The John and Jim patented claims produced gold and silver ore both of milling grade and of shipping grade in 1914. This property, equipped with a 2-stamp mill, is operated by the Economy Gold Mines Co. Lead oxidized ore, containing gold and a little silver, was shipped to the smelter from the Dobler property. The Kehern and Young Brothers placer diggings were producers of gold bullion.

Whitehall district.—Six deep mines produced 354 tons of shipping ore containing $20,896 in gold, 828 ounces of silver, 9,381 pounds of copper, valued in all at $22,602, or an average value per ton of $63.85. The larger part of the ore was shipped and carried gold and a little silver. Some copper ore was also produced. The output included the production of the Anna & Avon, Petaluma, Sunlight, Bismark, Mammoth, and American properties.

LEWIS AND CLARK COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Lewis and Clark County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1913	18	.....	$23,672	191	.....	.....	$23,787
1914	31	.....	8,310	80	.....	.....	8,354
DEEP MINES.							
1913	52	25,377	129,717	51,253	12,176	223,193	172,381
1914	42	25,348	112,121	59,776	16,167	804,511	178,703
Increase (+) or decrease (−) in in 1914	.....	−29	−32,958	+8,412	+3,991	+581,318	−9,111

Forty-two producers in 1914 reported 25,348 tons of ore—29 tons less than was reported by 52 producers in 1913. The total average value per ton increased from $6.79 in 1913 to $7.05 in 1914, and the gold and silver value in this ore decreased from $6.33 to $5.73 per ton. The larger part of the ore was of milling grade and produced gold and silver bullion, most of which was recovered by the cyanidation process and which yielded 3,405.53 ounces of gold and 8,811 ounces of silver. Crude ore shipped to the smelters amounted to 3,131 tons and contained $41,028 in gold, 50,925 ounces of silver, 15,949 pounds of copper, and 804,511 pounds of lead, valued in all at $102,687, or an average value per ton of $32.80. The largest part of the ore treated or sold (23,895 tons) was dry or siliceous in character. There were also 1,426 tons of lead ore, and only 27 tons were classified as copper ore. The placer output of 31 producers amounted to $8,310 in gold and 80 ounces of silver, against $23,672 in gold and 191 ounces of silver in 1913.

Bald Butte district.—Ore of milling grade was treated in the Bald Butte mill, 20 stamps of which operated about 4 days. Oxidized ore was taken out in prospecting the surface.

Big Blackfoot district.—Ore treated in an arrastre on the Lockey property yielded a small quantity of bullion. Development work consists of an adit tunnel approximately 150 feet long.

Dry Gulch district (including Cave Gulch).—This region yielded ores and placer bullion valued at $8,631 and reported by two deep mines and eight placers. All of the ore, (1,705 tons) was treated by cyanidation, the larger part in the 50-ton mill on the Golden Messenger and Dandy properties. These properties are opened by a vertical shaft 110 feet deep. The placers operated were the Bourbon in Cave Gulch, Borack in Oregon Gulch, and the New York Gulch placers. Some gold was also reported to have been recovered from placers in Magpie Gulch. The Magpie dredging plant, which was operated a short time in this region, is being moved (May, 1915) to the Dairy ranch in Colorado, 12 miles below Leadville.

Gould district.—A small output of gold and silver bullion was produced from the treatment of old tailings by the cyanide process from one property in the district. No other production was reported.

Greenhorn district.—The Umatilla property was under lease about 60 days in 1914 and produced gold bullion containing a little silver recovered from ores treated in a 5-stamp amalgamation mill.

Helena district.—Five deep mines and seven placers produced ore and bullion valued at $2,381. The larger part of the ore (92 tons) produced gold and silver bullion by the amalgamation process, and 12 tons containing gold and silver were reported as shipped directly to the smelter. The principal work done in the district was on the Yellow Boy property, and a small quantity of ore was treated in a 2-stamp amalgamation mill. It is reported that the sulphide ore extends to 100 feet in depth on this claim.

Jefferson Gulch district.—Gold and silver ore was milled from the Handicap and the Mukden properties, and, in addition to the gold bullion produced, a small quantity of gold and silver concentrate was shipped to the smelter. A small quantity of ore from the Dewett property was also treated and produced gold and silver bullion.

Lincoln district.—Gold and silver bullion, the output of six placer producers, contained $963 in gold and 7 ounces of silver. The largest part of this production was reported from the Old Billy Williams property, situated in McClellan Gulch. Bullion is said to have been recovered from old placer tailings.

Ottawa district.—Twelve deep-mine operators and one placer producer reported an output valued at $45,187. All the ore, except 25 tons shipped to the smelter, was of milling grade and amounted to 14,606 tons, which produced 1,985.99 ounces of gold and 6,297 ounces of silver. The principal producers were the Cruse and the Drumlummon properties. A considerable quantity of old tailings from Canyon Creek was treated and yielded gold and silver by the cyanidation process. The placer production amounted to $292 in gold and 2 ounces of silver.

Very little development work was done on the Piegan-Gloster mine[1] in 1914 because the Piegan ore body is already fairly well

[1] Barnes-King Development Co. Ann. Rept. for year ending Dec. 31, 1914.

blocked out above water and not much can be done in the Gloster until the shaft is unwatered. It is stated that the actual ore in sight in the Piegan-Gloster does not exceed 30,000 tons, with a gross value of $250,000. All that was left of the buildings and the old mill was put in shape for use during 1914, and the following equipment for the mill was nearly all installed: One No. 5 Symons gyratory crusher, with elevator and conveyor; three 10-foot Lane slow-speed Chile mills; two Wilfley concentrating tables; one Akins classifier; five leaching tanks, 10 by 26 feet; one Dorr thickener tank, 6 by 26 feet; and four Dorr agitating tanks, 8 by 24 feet.

Poorman district.—A small quantity of gold and silver bullion is reported to have been produced from the Mack mines. The Hard Work placer on Poorman Creek was also a producer.

Scratch Gravel district.—Considerable attention has been given to the development of the Franklin mine, which produced considerable siliceous gold ore and lead sulphides. This is an old property recently reopened.

Sevenmile district.—A small shipment of silver ore containing a little lead was made from the Saginaw group.

Stemple district.—Gold and silver bullion was recovered from ore treated in the Klondyke 5-stamp amalgamating mill. This property is opened by a tunnel 350 feet long. The Monkey and Peterson placers, situated on Lopear Gulch and Virginia Creek, respectively, produced a small quantity of bullion.

Springhill district.—The St. Louis placer, situated near Austin, produced a small quantity of bullion 0.773 in fineness, which was recovered by hydraulicking and sluicing.

Stonewall district.—A small test of copper oxidized ore was shipped to the smelter from quartz claims on Stonewall Mountain.

Threemile district.—Copper ore containing a trace of gold and silver was shipped from the Red Bird property. The claim is reported to have a shaft 280 feet deep.

Unionville district.—Siliceous gold ore containing a little silver was treated from the McIntyre and the Whitlatch properties in a mill belonging to the latter property and produced bullion and concentrates. The product recovered from the Whitlatch property consisted largely of ore from old pillars and fillings.

Vaughn district.—Three deep-mine producers reported 2,325 tons of milling ore and 936 tons of shipping ore. The latter contained 99.21 ounces of gold, 27,210 ounces of silver, and 497,879 pounds of lead. One shipment contained a trace of copper. The Columbia group, equipped with a 20-stamp amalgamation mill, was the largest producer of gold and silver bullion. This property is situated at the head of Ten Mile Creek, and the ore is mined at very low cost from surface workings. Lead sulphide ore, shipped from the Valley Forge property, contained silver and some gold. Considerable new development work was done on this property during 1914. Placer gold was recovered from the stream and bench gravels of the Dynamite and Perseverance properties. The Porphyry Dike Gold Mining Co. at Rimini erected a 20-stamp amalgamation mill. It is operating on the low-grade ores, and the net recoveries are said to be from $2 to $3 per ton in gold and silver.

LINCOLN COUNTY.

No ore was produced in the county in 1914, and a placer production of only $37 was reported.

Libby district.—On Big Cherry Creek, at the foot of Lookout Mountain, 13 miles south of Libby, the placers were under development and a small bullion output was reported. No record was made of any shipment of ore from the district, nor of any placer production, except the one from Big Cherry Creek. Improvements were reported to have been made on several of the placers by changing the pipe line and extending the ditches and flumes.

MADISON COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Madison County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
PLACERS.							
1913	16	.....	$691,651	4,880	.....	.....	$694,598
1914	13	.....	836,097	6,149	.....	.....	839,497
DEEP MINES.							
1913	105	17,248	178,746	77,573	25,983	262,490	241,178
1914	90	27,212	281,853	174,222	36,218	150,265	388,875
Increase (+) or decrease (−) in 1914	.....	+ 9,964	+247,553	+ 97,918	+ 10,235	−112,225	+292,596

Ninety operators in 1914 produced 27,212 tons of ore, 9,964 tons less than was produced by 105 operators in 1913. The total average value per ton increased from $13.98 in 1913 to $14.29 in 1914, and the gold and silver value from $13.08 to $13.90 per ton. The greater part of the ore was treated at gold and silver mills and amounted to 22,379 tons, yielding 2,980.93 ounces of gold and 88,134 ounces of silver, and also some concentrate. Only 380 tons of ore were directly concentrated. The shipping ore amounted to 3,253 tons, containing $145,420 in gold, 29,494 ounces of silver, 33,802 pounds of copper, and 112,463 pounds of lead, valued in all at $170,611, or an average value per ton of $52.45. Of the ore sold or treated 26,619 tons were dry or siliceous in character, 508 tons were lead ore, and 85 tons were copper ore. Placer bullion reported by 13 producers amounted to $836,097 in gold and 6,149 ounces of silver, against a placer output by 16 operators in 1913 of $691,651 in gold and 4,880 ounces of silver.

Alder Gulch district.—Thirteen deep mines shipped to smelters 173 tons of ore in 1914, containing $2,941 in gold, 3,443 ounces of silver, and 2,102 pounds of copper, valued in all at $5,125, or an average value per ton of $29.62. The placer output contained $835,479 in gold and 6,144 ounces of silver, and was reported by 6 operators. In 1913 the placer production reported by 11 operators amounted to $689,499 in gold and 4,861 ounces of silver. The principal part of the placer production was from the operations of 4 dredges on the Conrey placers.

Bone Basin district.—A small quantity of iron sulphide ore, containing gold and a little silver and copper, was taken from the Bonanza Fraction. This property is opened by tunnels 700 feet and 600 feet long, gaining at the face of the lowest tunnel a depth of about 400 feet below the surface. It is reported that the oxidized ores extend to a depth of 60 feet.

Lower Hot Springs district.—Reports received from 7 deep-mine operators show the shipment of 50 tons of ore containing gold and silver and a little lead, also the treatment of 32 tons of milling ore producing gold and silver bullion. The total value of the mine output amounted to $2,061, or an average value per ton of $25.13. The claims from which output was recorded were the Birdie, Florence, Red Bluff, and Valdez.

Mineral Hill district.—The reports of 10 deep-mine operators show a production of 10,158 tons of ore, containing $41,614 in gold, 1,797 ounces of silver, 2,671 pounds of copper, and 6,768 pounds of lead, valued in all at $43,227, or an average value per ton of $4.26. In 1913 the total value of the metals recovered was $37,720, at an average value of $5.15 per ton. In 1914 the greater part of the ore (10,056 tons) was milled and produced gold bullion and gold and silver concentrate. There were 102 tons shipped directly to the smelter, containing 233.23 ounces of gold, 365 ounces of silver, 1,109 pounds of copper, and 6,768 pounds of lead. The principal producer was the Boss Tweed and Clipper group, which was operated continuously throughout the year, the ore being treated in the 15-stamp amalgamation and concentration mill. Other producers were the Old Joe, Oregon, Gold Anchor, Eagle, Pan American, and Union.

Norwegian district.—Two small shipments of gold ore, containing a little silver and copper, were made from the Gold Hill property. Some ore taken from the Nabob property, formerly called the Black Chief, was milled at the Olmstead plant. Some custom ore also was treated at this mill, which is equipped for amalgamation and concentration with a Lane slow-speed roller mill and two Wilfley tables.

Rabbit (Rochester) district.—Four producers shipped from the district 125 tons of ore, containing $1,261 in gold, 2,091 ounces of silver, and 35,775 pounds of lead, valued in all at $3,812, or an average value per ton of $30.50.

Ramshorn district.—Two deep-mine and 5 placer operators reported the output of 317 tons of ore and placer bullion containing $1,963 in gold, 937 ounces of silver, 37,802 pounds of lead, and a little copper, valued in all at $4,048. The placers were operated in Harris, Bevins, and California gulches, and on Ramshorn Creek.

Sheridan district.—Ten deep-mine operators reported a production of 588 tons of ore containing $15,996 in gold, 1,378 ounces of silver, and a little copper, valued in all at $16,883, or an average value per ton of $28.71. Over half of the ore was of shipping grade, and the remainder was milled and produced gold and silver and a little concentrate. No placer production was reported. The principal operations in the district were carried on at the Tamarack property and by lessees on the Red Pine group.

Silver Star district.—Eleven deep-mine producers reported the shipment of 395 tons of shipping ore containing $12,660 in gold, 1,400 ounces of silver, 4,634 pounds of copper, and 3,814 pounds of lead, valued in all at $14,199, or an average value per ton of $35.95. The

owners of the Hudson, Blackman, Edgerton, and Aurora properties reported production.

Summit district.—There were 12,447 tons of ore and old tailings treated or shipped in 1914. The larger part, or 10,900 tons, was milled and produced gold and silver bullion and some gold-silver concentrate. Shipping ore amounted to 347 tons. The total output of ore contained $99,209 in gold, 146,397 ounces of silver, and a little copper, valued in all at $180,210, or an average value per ton of $14.48. The Easton-Pacific was the largest producer of milling ore, which was treated in its 10-stamp mill equipped with Chilean concentrator and cyanide plant. Producers shipping ore were the Elfleda, Fortune, Homestead and Black Rock, and Cornucopia properties.

Tidal Wave district.—Producers reported the treatment or sale from 12 properties in the district of 1,373 tons of ore yielding $24,278 in gold, 5,653 ounces of silver, 24,453 pounds of copper, and 65,402 pounds of lead, valued in all at $33,207, or an average value per ton of $24.19. The larger part of the ore (900 tons), was of milling grade, and produced gold and silver bullion, and 473 tons containing copper and lead were shipped directly to the smelters. The largest producer of milling ore was the Giant property, equipped with a 30-ton cyanide plant which began operations the latter part of December. The larger part of the shipping ore containing lead was produced from the Little Goldie group. Smaller producers of gold and silver ore of shipping grade were the Agnes, Aparanda, Argenta, Ella, Miners Union, and Topeka.

Upper Hot Springs district.—Three operators of deep mines shipped 28 tons of ore containing $2,060 in gold, 155 ounces of silver, and a trace of copper, valued in all at $2,147, or an average value per ton of $76.68. Some gold ore was shipped from the Lexington mine and from two other properties.

Washington district.—There were produced 1,378 tons of gold and silver ore, of which 1,149 tons, containing 3,628.70 ounces of gold and 10,731 ounces of silver, were shipped crude. Ore milled amounted to 229 tons and yielded gold and silver bullion and a small quantity of concentrate. The total value of the district output amounted to $82,399, or an average value per ton of $59.80. The largest producer was the property operated by the Missouri Mining Co., which is opened by 2 tunnels 645 feet and 750 feet in length. Production was also recorded from the Lehi No. 4 and George McKee properties.

MEAGHER COUNTY.

The production of 26 tons of ore in 1914 is 21 tons more than was produced in 1913, but the total average value per ton of the ore decreased from $41.40 in 1913 to $37.81 in 1914. All the ore was shipped in 1914 and contained zinc and copper. Two placer operators reported the production of $186 in gold and 2 ounces of silver, against the output by 3 placer operators in 1913 of $774 in gold and 6 ounces of silver.

Diamond district.—A small placer production was recorded from the Old Beaver Creek property.

Elk Creek district.—Placers produced some gold nuggets, which were sold to jewelers.

Musselshell district.—Operators of the Blue Eyed Nellie claim, which is said to be situated in the Robinson district, shipped some oxidized zinc ore. Lessees operated the St. John and Darling Fraction properties, which produced little copper ore.

MISSOULA COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Missoula County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
Placers:		*Short tons.*	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	21	.....	$14,527	33	.....	.....	.....	$14,547
1914	20	.....	21,154	39	.....	.....	.....	21,176
Deep mines:								
1913	7	13,836	8,709	36,861	90,329	415,073	78,999	67,661
1914	7	11,858	17,796	38,260	24,536	441,240	100,538	64,551
Increase (+) or decrease (−) in 1914		−1,978	+15,714	+1,405	−65,793	+26,167	+21,539	+3,519

A portion of Missoula County became Mineral County August 7, 1914. The new county borders Idaho from St. Regis Pass southeastward to a point within a few miles of Lolo Pass, thence it runs north to Missoula River, thence follows the range dividing Missoula River from Ninemile Creek to the Sanders County border, and thence to the point of beginning. This change in county lines will put all the mining districts except the Ninemile (Kennedy Creek), Wallace (Clinton), and Woodman (Mormon Creek) in Mineral County. The mine output for 1914 is all credited to Missoula County, which had 7 deep-mine operators who produced 11,858 tons of ore, 1,978 tons less than was produced by the same number of operators in 1913. The total average value per ton of the ore increased from $4.89 to $5.44, and the gold and silver value per ton in this ore from $2.24 to $3.28. The greater part of the ore was concentrated into lead-zinc concentrates, and 3,230 tons were treated at gold and silver mills and yielded 858.68 ounces of gold and 58 ounces of silver. Shipments from the county directly to the smelters amounted to 371 tons of ore, containing $46 in gold, 14,660 ounces of silver, 24,536 pounds of copper, and 145,524 pounds of lead, valued in all at $17,090, or an average value per ton of $46.07. Placer bullion reported by 20 producers amounted to $21,154 in gold and 39 ounces of silver, against a placer output by 22 operators in 1913 of $14,527 in gold and 33 ounces of silver.

Cedar Creek district.—Outside of a small shipment by one producer of ore containing copper and silver, all the other producers, 15 in number, were placers. The total yield of the district was $17,905 in gold, 113 ounces of silver, and 21,058 pounds of copper, valued in all at $20,769. The Amador property shipped a small quantity of copper sulphide ore. This property is developed by a vertical shaft 700 feet deep. Among the placers, the Cedar Creek property, equipped with a dredge, was the principal producer. Other placers producing were the Louisiana, Blue Bird, California, Eclipse, Dakota, Meadow Creek, Ohio Gulch, Stockholm, Sunrise, and C., B. & Q.

Iron Mountain district.—The Iron Mountain Tunnel property in 1914 produced ore from which lead and zinc concentrates carrying silver were recovered. Some crude ore also was picked from sorting

dumps and shipped directly to the smelter. The milling plant is equipped for wet concentration with jigs, concentrating tables, and a flotation process.

Ninemile district.—Two deep-mine operators produced 3,230 tons of milling ore that yielded gold and silver bullion, which, with the output from 5 placers, made the total output of the district aggregate $20,999 in gold and 63 ounces of silver, valued in all at $21,034. The average recovery of bullion from the milling ore was $5.50 per ton. Producers of this class of ore were the Ninemile and Martina groups. Both properties are equipped with milling plants, the former treating its ore by cyanidation and the latter by amalgamation. The principal placers producing were the Chrysalis, Pine Creek, and Slide.

Ravalli district.—Ores shipped from the McDonald property contained copper and a little silver and gold.

Saltese district.—Some shipments of copper ore were reported from the Bald Mountain claims.

Wallace district.—A small quantity of silver ore containing copper and gold was reported to have been shipped from the Montana property.

PARK COUNTY.

No ore was produced in Park County in 1913 or 1914. In 1912 the mines in the county produced 179 tons of ore. Five producers of placer bullion reported $888 in gold and 4 ounces of silver in 1914, against $2,554 in gold and 16 ounces of silver in 1913.

Cowles district.—Placer claims on Basin Creek yielded a small quantity of gold.

Emigrant Creek district.—Various placers, among them the Pittsburg and the Bob Tail, produced some gold and silver bullion during 1914.

POWELL COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Powell County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Placers:							
1913	22	.....	$23,732	111	.....	.....	$23,799
1914	23	.....	25,302	183	.....	.....	25,403
Deep mines:							
1913	18	2,177	23,132	60,523	126,882	30,012	80,675
1914	13	1,854	20,080	64,257	78,386	81,717	69,226
Increase (+) or decrease (−) in 1914		−323	−1,482	+3,806	−48,496	+51,705	−9,845

Thirteen operators in Powell County in 1914 produced 1,854 tons of ore, 323 tons less than was produced by 18 operators in 1913. The value per ton of the ore increased slightly from $37.06 in 1913 to $37.34 in 1914, and the gold and silver value from $27.42 to $30 per ton. Except 31 tons which was treated at a gold and silver mill, the rest of the ore, amounting to 1,823 tons, was shipped directly to smelters; it contained $19,483 in gold, 64,254 ounces of silver, 78,386 pounds of copper, and 81,717 pounds of lead, valued in all at $68,627, or an average value per ton of $37.65. Twenty-three placer producers reported an output of $25,302 in gold and 183 ounces of silver in 1914, against

22 producers and an output of $23,732 in gold and 111 ounces of silver in 1913.

Bear Gulch district.—From a locality near Summit, 2 miles east of Garnet, some placer bullion was produced, said to have had a fineness of about 0.913 in gold.

Big Blackfoot district.—Some gold dust from placers was reported to have been produced in the district from development work on various properties.

Coloma district.—Three placers produced $418 in gold and 3 ounces of silver. Part of the ground was worked by hydraulic elevator. All the operations were on Elk Creek.

Copper Cliff district.—A small production of copper oxidized ore containing gold was shipped from one property in the district.

Ontario district.—Four deep-mine operators shipped 189 tons of ore, containing $5,731 in gold, 823 ounces of silver, 1,719 pounds of copper, and 12,467 pounds of lead, valued in all at $6,900, or an average value per ton of $36.51. Lead ore bearing gold and silver was shipped from the Big Dick property. The Centralia group, situated 2 miles south of Blossburg, on Olson Peak, produced siliceous gold ore carrying some silver and a trace of copper. The Daylight claim produced gold ore carrying silver. Some gold bullion from two placers is also credited to the district.

Ophir district.—Four deep-mine operators produced 1,439 tons of ore, which yielded $11,471 in gold, 53,393 ounces of silver, 71,578 pounds of copper, and 30,450 pounds of lead, valued in all at $51,705, or an average value per ton of $35.93. All this ore, with the exception of 22 tons producing gold and silver bullion, was shipped directly to the smelter. The Julia property produced two grades of ore, one of copper and the other of lead, both containing silver and gold. The placer production reported from 6 sources amounted to $1,058 in gold and 5 ounces of silver, having a total value of $1,061.

Pioneer district.—Four placer producers reported the output of $22,331 in gold and 164 ounces of silver, valued in all at $22,421. The Pioneer, Friday, and Upper Gold Creek placers were the principal producers.

Race Track district.—A small arrastre erected at Danielsville operating in 1914 on quartz float produced a small quantity of gold bullion.

Washington Gulch district.—The Ruther, Gerdt's, and Scotch Bar placers produced bullion amounting to $936 in gold and 5 ounces of silver.

Zozell district.—Three deep-mine operators shipped 190 tons of ore, containing $2,633 in gold, 10,025 ounces of silver, 1,727 pounds of copper, and 38,800 pounds of lead, valued in all at $9,920, or an average value per ton of $52.21. Lead ore containing silver, some gold, and a little copper was mined principally from the Argus claim, and siliceous gold and silver ore were produced from the Emery and Blued Eyed Maggie properties.

RAVALLI COUNTY.

Two deep-mine operators in 1914 reported the output of 39 tons of ore, 27 tons less than was reported by 3 operators in 1913. The total average value per ton of the ore increased from $22.92 in 1913

to $28 in 1914, and the gold and silver value from $8.82 to $17.69 per ton. All the ore was of shipping grade. The placer output made by 3 producers, was $6,260 in gold and 20 ounces of silver, as against 2 producers, $10,383 in gold, and 31 ounces of silver in 1913.

Curlew district.—A small lot of oxidized lead ore carrying silver was shipped from the Curlew and Elizabeth group.

Hughes Creek district.—The Wood Placer Mining Co. was the principal producer of placer gold in the district in 1914.

Pleasant View district.—Silver ore containing a little copper and a trace of gold was shipped from the Pleasant View property, near Victor. This property is opened by an incline shaft 165 feet deep with 3 drifts.

SANDERS COUNTY.

One operator in 1914 shipped 122 tons of copper-lead ore, 1,118 tons less than was produced in 1913 by 7 producers. The total average value per ton of the ore increased from $31.75 in 1913 to $55.33 in 1914, and the gold and silver value from $10.13 to $16.64 per ton.

Prospect Creek district.—A small production of gold bullion is credited to one placer property which was reported as situated in this district.

Spring Gulch district.—Copper-lead ore, mostly sulphide, containing silver and a little gold, was shipped from the King and Queen property directly to the smelter in 1914. A new concentrator of daily capacity of 125 tons was built in 1913 for the treatment of lead-silver ore from this mine.

Trout Creek district.—Two placers reported the production of $747 in gold and silver in 1914.

SILVER BOW COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Silver Bow County, Mont., in 1913 and 1914.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1913	84	5,612,530	$779,744	12,211,725	285,681,558	4,542,225	88,529,074	$57,593,753
1914	67	4,749,189	657,176	10,511,032	232,188,628	5,386,356	109,542,542	43,147,603
Increase (+) or decrease (−) in 1914		−863,341	−122,568	−1,700,693	−53,492,930	+844,131	+21,013,468	−14,446,150

[a] Includes placer production.

The greater part of the ore produced in this county came from the Butte or Summit Valley district, the remainder coming from adjacent districts. Sixty-one operators in 1914 produced 4,749,189 tons of ore, 863,341 tons less than was produced by 78 operators in 1913. The output of ore was chiefly from the holdings of a few producers whose property covers a considerable area at Butte. The majority of the producers are merely lessees on various properties. The total average value per ton of the ore produced in the county decreased from $10.26 in 1913 to $9.08 in 1914, and the gold and silver value per ton from

$1.45 to $1.36. The gold produced from deep mines and placers decreased in value from $779,744 in 1913 to $657,176; the silver from $7,375,882 in 1913 to $5,812,601; and the copper from $44,280,641 in 1913 to $30,881,088. Owing to the increased quantity of lead-zinc ore produced the value of the lead increased from $199,858 in 1913 to $210,068 in 1914, and that of the zinc from $4,957,628 to $5,586,670. In total value the entire output decreased from $57,593,753 in 1913 to $43,147,603 in 1914. The greater part of the ore produced (4,110,010 tons) was concentrated at milling plants situated at Butte, Anaconda, and Great Falls. The copper concentrates, lead concentrates, and zinc concentrates aggregated 1,432,109 tons, containing $473,568 in gold, 8,091,780 ounces of silver, 167,772,257 pounds of copper, 5,337,246 pounds of lead, and 109,542,542 pounds of zinc, valued in all at $33,056,855, or an average value per ton of $23.08. The crude smelting ore amounted to 582,501 tons, containing $179,646 in gold, 2,419,069 ounces of silver, 57,918,215 pounds of copper, and 49,110 pounds of lead, valued in all at $9,222,430, or an average value per ton of $15.83. Gold and silver bullion was produced from 23 tons of ore treated at a gold and silver mill. The ore production was classified as 4,342,937 tons of copper ore, 393,663 tons of lead-zinc ore, 12,486 tons of dry or siliceous ore, 46 tons of copper-lead ore, and 57 tons of lead ore. The placer output was $3,589 in gold and 51 ounces of silver, as against $5,211 in gold and 27 ounces of silver in 1913.

Divide Creek district.—Seven deep-mine operators produced 135 tons of shipping ore containing $318 in gold, 2,305 ounces of silver, 12,968 pounds of copper, and 33,652 pounds of lead, valued in all at $4,631, or an average value per ton of $34.30. Producers reported the shipment of ore from the Black Jacket, Irene, Red Rose, and Mountain Consolidated mines, and a small output of placer bullion was produced from the Nugget placer in Soap Gulch.

Highland district.—One deep mine and 3 placers produced $3,441 in gold, 405 ounces of silver, and 406 pounds of copper, valued in all at $3,719. The Brooks claim produced copper ore containing silver and a trace of gold. Among the placers, the Highland was the principal producer.

Summit Valley or Butte district.—The production of Silver Bow County, the great bulk of which is from the Butte district, from 1882 to the end of 1914, inclusive, amounted in gold, silver, copper, lead, and zinc to $1,139,582,829, distributed as follows: $26,925,692 for gold, $197,577,911 for silver, $896,675,359 for copper, $723,612 for lead, and $17,680,255 for zinc. The quantities of each metal produced are given for each year from 1882 to 1913 in the report for 1913 [1] and by periods from 1882 to 1914 in the following table:

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 615, 1914.

Production of gold, silver, copper, lead, and zinc, and total gross value of output of Silver Bow County, Mont., 1882–1914, by periods.

Period.	Gold.[a]	Silver.[a]	Copper.[b]	Lead.[a]	Zinc (spelter).	Total value.[c]
	Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1882–1890	$5,030,369	51,060,644	590,026,154	50,000	.....	$140,307,364
1891–1900	9,582,941	90,716,046	1,957,968,308	536,198	.....	320,697,550
1901–1910	9,348,914	99,520,195	2,740,026,871	3,857,144	50,941,438	474,555,403
1911	731,905	10,258,122	272,271,171	1,017,273	43,734,150	42,741,229
1912	794,643	11,352,106	308,222,547	1,296,283	26,792,550	60.539,927
1913	779,744	12,211,725	285,681,558	4,542,225	88,529,074	57,593,753
1914	657,176	10,511,032	232,188,628	5,386,356	109,542,542	43,147,603
Total	26,925,692	285,629,870	6,386,385,237	16,685,479	[d]319,539,754	1,139,582,829

[a] Figures from reports of Director of the Mint, 1882–1903, and from Mineral Resources, 1904–1914.
[b] Figures from Mineral Resources.
[c] Average commercial price used for each metal in calculating value for each calendar year.
[d] Total zinc is correction from total given in table by years in report for 1913.

The operators reporting production in 1914 were the Anaconda Copper, North Butte, East Butte, Elm Orlu, Butte-Superior, Tuolumne, Davis Daly, Butte Duluth, Pilot Butte, Alex Scott, Balaklava, and Garfield-Salvador companies, and the Goldsmith, Poser, Moulton, Reliance, Amy, and Preferencia mines. Important milling operations were carried on in the district and on ores shipped to plants outside the district, so that the production of copper, which formerly represented a recovery of about 78 per cent, will likely be 90 per cent in the near future. At one zinc plant the average recovery of zinc for 1914 is reported to be 88.71 per cent. The improvements effecting these savings are reviewed under the chapter on metallurgy.

The mines of the Anaconda Copper Mining Co.[1] in 1914 produced 3,898,100.15 tons of ore and 6,782.43 tons of precipitates, or a total of 3,904,882.58 tons. The reduction works treated for all companies 3,748,726.49 tons of ore and other cupriferous material at Anaconda, and 488,243.73 tons of ore and other cupriferous material at Great Falls. Of this quantity, 3,768,640.01 tons of ore came from company mines, 467,903.97 tons of ore were purchased from or treated for other companies, and 426.24 tons of precipitates and cleanings were from the old works; and from this quantity there was produced 188,664,551 pounds of fine copper; 7,555,915.11 ounces of silver, and 78,815.428 ounces of gold at Anaconda; and 35,055,741 pounds of fine copper, 758,200.54 ounces of silver, and 20,835.558 ounces of gold at Great Falls, or a total production of 223,720,292 pounds of fine copper, 8,314,115.65 ounces of silver, and 99,650.986 ounces of gold. Of this total 205,298,531 pounds of fine copper, 7,221,815.31 ounces of silver, and 99,650.986 ounces of gold were produced by the company.

According to the annual report[2] covering the operations of the Dutton-Pittsmont mine and smelter, 72,853 tons (wet) of ore were mined, containing an average of 4.72 per cent of copper and costing $5.39 per ton to mine (cost of development included). The mill and smelter treated 71,918 dry tons of company ore and 39,074 dry tons

[1] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[2] East Butte Copper Co. Ann. Rept. for year ending Dec. 31, 1914.

of custom ore, from which was recovered 9,175,579 pounds of copper, 242,347 ounces of silver, and 2,219 ounces of gold. The property was not operated the entire year. The following extract is from the company's report:

> For the first seven months of 1914, the operations of your company were conducted under the same conditions as in preceding years. Production was at a slightly higher rate than in 1913, and costs of copper were substantially the same. * * *
> On account of this * * * the property was closed down on August 8, 1914. Therefore the property was in operation 220 days only during the year, and was idle almost 40 per cent of the time in 1914.

During 1914 there were mined from the North Butte mine[1] 337,372 dry tons of ore and 43.35 dry tons of copper precipitate (from mine water), which produced 18,421,761 pounds of copper, 1,092,300 ounces of silver, and 1,107.59 ounces of gold. Of the ore mined, 60,527 tons was smelted directly; the second-class ore, 276,845 tons, was concentrated. During the first part of August the working force at the North Butte mine was reduced 50 per cent and the mine was later closed, pending repairs to the Speculator shaft. It is stated that the total cost to December 31, 1914, for sinking the Granite Mountain shaft 3,100 feet on the North Butte property amounted to $222,604, which includes the cutting of stations and driving of cross-cuts to connect mine workings. The new machinery for the Granite Mountain shaft is said to consist of the largest electrical hoist built in the United States, costing with subsidiary equipment $228,239 to the end of 1914.

There were mined in 1914 in the Tuolumne[2] property 23,683 dry tons of ore containing 1,945,286 pounds of copper, 115,355.78 ounces of silver, and 150.86 ounces of gold. The gross smelter value of the entire product was $201,651.78, and the net value received from the smelter was $136,513.33. The average copper content of the ore for the year was 4.10 per cent, an increase in grade over 1913 which averaged 3.84 per cent copper.

From the Pilot Butte[3] property were produced 3,730 tons of ore, which contained 368,261 pounds of copper, 19,083 ounces of silver, and 27.84 ounces of gold. This ore averaged 4.94 per cent of copper, and 5.11 ounces of silver, and 0.007 ounce of gold per ton. The property is opened by a 3-compartment vertical shaft 2,400 feet deep. A shoot of high-grade zinc ore 75 feet in length and 2 to 8 feet in width was reported on the 2,200 level, and on the 2,400-foot level a vein for a distance of 5 feet was reported to assay 15 per cent zinc and 4 ounces of silver per ton. The Bornite vein opened on the 2,400-foot level is said to be 8 to 10 feet in width, and samples taken from the mineralized portion 2 to 7 feet in width assayed 5 per cent of copper and 5 ounces of silver. The Gow and the Glance veins were also explored to some extent.

In the Butte-Superior[4] property only sufficient development work was undertaken to maintain substantially the existing ore reserves, and an estimate of ore actually blocked out on December 31, 1914, showed about 1,030,000 tons averaging 20 per cent zinc and 7 ounces of silver, according to the report of the company. This was only about 20,000 tons less than the ore reserves one year prior to

[1] North Butte Mining Co. Quarterly Repts. for year ending Dec. 31, 1914.
[2] Tuolumne Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[3] Pilot Butte Mining Co. Ann. Rept. for year ending Dec. 31, 1914.
[4] Butte & Superior Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1914.

that date. The silver content, however, was somewhat lower, as is explained in the accompanying extract from the company's report. The ore actually milled during the year did not carry as high zinc content as was shown in the last annual estimate of ore reserves. That was because improved metallurgical efficiency warranted the mining of a considerable quantity of low-grade ore not previously included in estimates of ore reserves, thus adding greatly to the profitable life of the property. The following extract is from the company's report:

The total ore mined for the year was 326,686 tons at an average cost for the year of $3.20 per ton, including all expenses for development work directly connected with mining and blocking out ore reserves, but exclusive of exploration work on outlying claims. * * *

The tonnage milled for the year was 327,210 tons, as compared to 296,940 tons for the previous year. The tonnage stated for 1914 was treated in ten months actual operation due to the two months' shutdown in the last quarter. Had the mill operated at normal capacity for the full year the total amount of ore treated would have been about 400,000 tons.

Crude ore treated and concentrates produced at Butte-Superior mill, showing total content and average assay of ore and product in 1914.

Ore and product.	Tonnage.	Gold.		Silver.	
		Total content.	Average per ton.	Total content.	Average per ton.
		Ounces.	*Ounce.*	*Ounces.*	*Ounces.*
Crude ore, milled	327,210	6,401.01	0.0196	3,118,810.41	9.5315
Zinc concentrate	101,411	5,116.49	.0504	2,578,758.72	25.4288
Lead concentrate	2,972	212.64	.0716	120,385.15	40.512

Ore and product.	Copper.		Lead.		Zinc.	
	Total content.	Average.	Total content.	Average.	Total content.	Average.
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
Crude ore, milled	1,318,336	0.2015	8,770,222	1.3402	121,545,158	18.5730
Zinc concentrate	968,185	.4774	4,941,850	2.4365	107,828,679	53.1642
Lead concentrate	17,708	.298	2,759,521	46.432	[a] 815,441	13.7210

[a] Zinc not paid for in lead concentrate.

The average grade of ore milled for the year was 1 per cent less than for the year 1913, principally because of increased efficiency in the mill which made it possible to profitably treat lower-grade material. The silver contents of the crude ores was about an ounce less than for the year 1913, due to a smaller proportion of tonnage coming from the old upper levels of the mine where silver values are higher.

The mill recovery for the year averaged 88.71 per cent as compared with 86.43 per cent for the previous year, and the average cost of milling was $2.12 per ton as compared with $2.69 for the previous year. The total cost of mining and milling for the year was $5.33 as compared with $5.83 for the previous year. The cost of producing a pound of zinc based upon the total pounds contained in zinc concentrates was 3.73 cents as compared with 4.16 cents for the previous year. This cost is based on actual smelter returns and is derived by applying the values received for all metals other than zinc as a credit to the cost of producing zinc.

The increased grade of concentrates produced during the year as compared to that of the previous year is responsible in a great measure for the decrease in cost of production. The concentrates produced for the year 1913 contained 49 per cent zinc as against over 53 per cent as previously shown for the year 1914. This factor also had largely to do with increasing the net returns per ton of ore milled from $8.86 during the year 1913 to $9.25 for the year 1914, notwithstanding the fact that the price of zinc averaged considerably lower for the latter than for the former year.

At Timber Butte, the mill constructed for the treatment of Elm Orlu zinc ores was started in June, 1914. The ore treated is a mixture of zinc, lead, and copper sulphides in a siliceous gangue assaying 17 to 22 per cent of zinc. The mill includes both wet concentration and flotation departments, which have been making satisfactory recoveries according to a recent article:[1]

Starting with an ore containing 19 per cent plus of zinc, a final mill tailing is made assaying 0.7 to 2 and averaging about 1½ per cent. The concentrate delivered to the bin from the flotation department assays about 53 per cent zinc, 4.2 iron, and 3 to 4 insoluble. Concentrate from tables prior to flotation assays about 48 per cent zinc, 8 per cent iron, and 4½ per cent insoluble. The lead-iron concentrate ranges from 18 to 28 per cent zinc, 18 to 22 iron, and 10 to 35 lead. The jig concentrate assays 40 to 48 per cent zinc, 8 to 12 per cent iron, and 3 to 4 insoluble. For one period of six days the total mill recovery averaged 95.7 per cent. For the same period the average recovery by flotation, from the leaner ore, was 93.7 per cent. In treating nearly 11,000 tons, 24.6 per cent of the zinc was saved in the coarse concentrate and 69.4 in the fine. In the lead-iron concentrate 0.6 per cent of the zinc was lost, while 5.1 went into the tailing, and 0.3 per cent was unaccounted for.

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LEAD.

By C. E. Siebenthal.

INTRODUCTION.

An estimate of the production of refined lead in 1914 was given out in the form of a press bulletin on January 3, 1915. This was based on reports from every smelter, giving the actual production for the first 10 or 11 months of 1914, with estimates for the remainder of the year. The total thus obtained was a little less than 1 per cent short of the final figures of production. The complete figures of production and consumption of primary [1] refined lead and of imports and exports of lead in ore and bullion were given in the advance statement of lead production, which was published April 2, 1915. The present report contains, in addition, tables and curves showing the production, value, consumption, imports, exports, and prices for a period of years, a comparison of the mine and the smelter production of lead since 1907, a list of lead smelters, and a summary of metallurgical advance in 1914.

The statistics of production of lead in this country in 1914 have been compiled by the United States Geological Survey from confidential reports by each lead-smelting company in operation during the year. The statistics of the recovery of secondary lead were also collected by the United States Geological Survey. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and the tables for foreign production and consumption were compiled from the sources indicated.

STATE OF LEAD INDUSTRY IN 1914.

The output of refined lead produced in the United States from domestic ores in 1914 was 512,794 short tons, valued at $39,997,932, based on the average New York price of refined lead, as compared with 411,878 tons, valued at $36,245,264, based on the average New York price in 1913, a gain of 100,916 tons, equal to nearly 25 per cent, in quantity and of $3,752,668, equal to a little more than 10 per cent, in value. The production in 1912 was 392,517 tons, valued at $35,326,530, and in 1911 it was 391,995 tons, valued at $35,279,550, all values being based on the average New York price.

[1] By primary lead is meant lead which has been produced directly from ore. This term is used for purposes of distinction from secondary lead, which is obtained by refining skimmings, drosses, old metals, etc., figures for the production of which are given on a later page. Wherever in this report the word "lead" is used without qualification primary lead is to be understood.

The imports of ore and more particularly of bullion from Mexico continued to decline on account of the civil strife in that country, amounting to a little more than a third of what they were in the years preceding 1913. The continued demand from Europe for lead for use in the war, thus had to be satisfied from lead of domestic origin, the production of which was so encouraged that the output was nearly a hundred thousand tons greater than ever before.

The largest contribution made by any State to the domestic output of lead was made by Missouri, 194,275 tons, a gain of 41,845 tons, more than 27 per cent, over 1913, which enabled that State to retain first position in lead production, which rank was seriously threatened by Idaho, making the next largest gain, 40,025 tons, or 29 per cent. Utah also made a good gain of 17,907 tons, or 25 per cent. The other States made no material changes in their output from that of 1913.

As has been true for several years, certain important producers were unwilling to report stocks of lead on hand at the close of the year, so that it is not possible to state accurately the deliveries to consumption. As the next best thing, the lead available for consumption is calculated from the domestic production, together with imports, exports, and stocks of foreign lead in bonded warehouse.

PRODUCTION.

PRODUCTION AND VALUE, 1720–1914.

The production and value of refined lead in the United States since 1720 from domestic ores and from foreign ores and base bullion is shown in the tables following. For the early years, in the absence of official records, the figures have been compiled from the best available sources. The lump estimate for the period 1720–1824 includes Winslow's estimate of the quantity and value of the output of lead in Missouri and estimates by the author of the production and value of lead in Massachusetts, Connecticut, Pennsylvania, Virginia, and the upper Mississippi Valley region. The figures for the period from 1825 to 1853 are based on those published by Whitney; those for the later years were collected by E. A. Caswell. Totals for 1882 were compiled from statistics gathered by the Census Bureau. Since 1882 the figures have been annually collected by the United States Geological Survey.

According to Hahn,[1] argentiferous-lead ore was smelted in Montana and Nevada as early as 1866–67, but for the silver only, as the value of the lead would not pay transportation charges to market. With the completion of the Union Pacific Railroad in 1869 and the development of the mines at Eureka, Nev., the production of lead bullion began. The first figures of this production which are available are for 1873. It is evident from the totals for 1871 and 1872 that not much bullion was produced before 1873. Estimates have been made for these years, as well as for 1874, in order to arrive at totals for the different classes of lead. Foreign bullion, principally from Mexico, began in 1891 to be imported into this country for refining, but before 1906 the annual quantities so imported were not

[1] U. S. Geol. Survey Mineral Resources, 1882, p. 324, 1883.

distinguished in the statistical record of general imports from the lead imported in ore. As the soft lead is all domestic, the desilverized lead of domestic origin can be readily found by subtracting the total lead of foreign origin from the total desilverized-lead production of that year, or by subtracting the soft lead from the total domestic lead of that year.

In the following table, and in less comprehensive tables as published heretofore, the total production of antimonial lead, prior to 1906, was included in the desilverized lead, the lead from domestic ores and base bullion, and the total production of lead. It has seemed better to deduct the antimonial lead from these columns, however, and to give it in a separate table. The total recorded production of antimonial lead has been found to be just 3 per cent of the total production of desilverized lead for the same years. Estimates have therefore been made of the output of antimonial lead reaching back to the first production of desilverized lead, and these quantities have been deducted from the desilverized lead, total lead, and domestic lead for the corresponding years, so that the table as given herewith includes no antimonial lead.

The annual price of lead at New York prior to 1882 is from a table published in Mineral Industry for 1894. Since 1882 the price given is that which has been used in these reports. The total production for the period 1720–1914 divided into the total value gives $0.044 as the average price per pound.

Production, price per pound, and value of refined lead in the United States, 1720–1868.[a]

Year.	Production.	Price at New York.	Value.	Year.	Production.	Price at New York.	Value.
	Short tons.				*Short tons.*		
1720–1824	55,700	.....	$5,228,000	1848	25,000	$0.043	$2,150,000
1825	1,500	$0.076	228,000	1849	23,500	.048	2,256,000
1826	2,000	.068	272,000	1850	22,000	.048	2,112,000
1827	4,500	.061	549,000	1851	18,500	.049	1,813,000
1828	8,500	.054	918,000	1852	15,700	.048	1,507,200
1829	8,500	.038	646,000	1853	16,800	.065	2,184,000
1830	8,000	.038	608,000	1854	16,500	.066	2,178,000
1831	7,500	.053	795,000	1855	15,800	.069	2,180,400
1832	10,000	.059	1,180,000	1856	16,000	.066	2,112,000
1833	11,000	.059	1,298,000	1857	15,800	.062	1,959,200
1834	12,000	.051	1,224,000	1858	15,300	.059	1,805,400
1835	13,000	.065	1,690,000	1859	16,400	.055	1,804,000
1836	15,000	.064	1,920,000	1860	15,600	.057	1,778,400
1837	13,500	.060	1,620,000	1861	14,100	.053	1,494,600
1838	15,000	.053	1,590,000	1862	14,200	.061	1,732,400
1839	17,500	.058	2,030,000	1863	14,800	.063	1,864,800
1840	17,000	.049	1,666,000	1864	15,300	.071	2,172,600
1841	20,500	.045	1,845,000	1865	14,700	.066	1,940,400
1842	24,000	.038	1,824,000	1866	16,100	.069	2,221,800
1843	25,000	.036	1,800,000	1867	15,200	.065	1,976,000
1844	26,000	.039	2,028,000	1868	16,400	.065	2,132,000
1845	30,000	.040	2,400,000				
1846	28,000	.047	2,632,000	Total	755,400	.....	79,829,200
1847	28,000	.044	2,464,000				

[a] Since the publication of the prices given in the prefatory note, the prices for lead have been carried out in most instances to tenths of a cent for the purposes of this table.

Production, price per pound, and value of refined lead in the United States, 1720–1914.[a]

Year.	Desilverized lead.[b c]	Soft lead.[d]	Total production.[c]	From domestic ores and base bullion.[c]	From foreign ores.[e]	From foreign base bullion.[f]	Price at New York.	Value.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*		
1720–1868	.....	755,400	755,400	755,400	.....	.....	.....	$79,829,200
1869	.....	17,500	17,500	17,500	.....	.....	$0.065	2,275,000
1870	.....	17,830	17,830	17,830	.....	.....	.063	2,246,580
1871	*g* 970	*g* 19,000	19,970	19,970	.....	.....	.061	2,436,340
1872	*g* 5,220	*g* 20,500	25,720	25,720	.....	.....	.063	3,240,720
1873	19,559	22,381	41,940	41,940	.....	.....	.063	5,284,440
1874	*g* 27,674	*g* 23,556	51,230	51,230	.....	.....	.060	6,147,600
1875	33,859	24,731	58,590	58,590	.....	.....	.059	6,913,620
1876	36,519	26,421	62,940	62,940	.....	.....	.061	7,678,680
1877	49,228	31,152	80,380	80,380	.....	.....	.055	8,841,800
1878	62,360	26,770	89,130	89,130	.....	.....	.036	6,417,360
1879	62,710	28,130	90,840	90,840	.....	.....	.041	7,448,880
1880	68,035	27,690	95,725	95,725	.....	.....	.050	9,572,500
1881	83,725	30,770	114,495	114,495	.....	.....	.048	10,991,520
1882	100,765	29,015	129,780	129,780	.....	.....	.049	12,718,440
1883	118,497	21,800	140,297	140,297	.....	.....	.043	12,065,542
1884	116,365	19,932	136,297	136,297	.....	.....	.037	10,085,978
1885	104,217	21,975	126,192	126,192	.....	.....	.040	10,095,360
1886	111,389	20,800	132,189	127,189	5,000	.....	.046	12,161,388
1887	131,482	25,148	156,630	141,630	15,000	.....	.045	14,096,700
1888	146,925	29,090	176,015	147,379	28,636	.....	.044	15,489,320
1889	149,099	29,258	178,357	151,787	26,570	.....	.039	13,911,846
1890	126,493	31,351	157,844	139,720	18,124	.....	.045	14,205,960
1891	166,966	31,397	198,363	174,511	23,852	.....	.043	17,059,218
1892	176,545	31,678	208,223	168,266	39,957	.....	.041	17,074,286
1893	191,807	32,513	224,320	158,969	65,351	.....	.037	16,599,680
1894	175,964	37,686	213,650	153,911	59,739	.....	.033	14,100,900
1895	195,932	39,890	235,822	159,649	76,173	.....	.032	15,092,608
1896	213,950	43,537	257,487	179,749	77,738	.....	.030	15,449,220
1897	238,616	43,553	282,169	198,498	83,671	.....	.036	20,316,168
1898	259,369	42,779	302,148	202,203	99,945	.....	.038	22,963,248
1899	257,481	40,566	298,047	202,121	95,926	.....	.045	26,824,230
1900	319,752	48,021	367,773	260,918	106,855	.....	.044	32,364,024
1901	313,134	57,898	371,032	258,610	112,422	.....	.043	30,908,752
1902	293,842	74,050	367,892	267,286	100,606	.....	.041	30,167,144
1903	285,495	83,444	368,939	280,615	88,324	.....	.042	30,990,876
1904	304,283	89,169	393,452	297,602	95,850	.....	.043	33,836,872
1905	302,852	85,455	388,307	307,514	80,793	.....	.047	36,500,858
1906	313,886	90,860	404,746	336,200	28,803	39,743	.057	46,141,044
1907	313,588	99,801	413,389	352,381	24,041	36,967	.053	43,819,234
1908	295,552	101,012	396,564	311,666	11,509	73,389	.042	33,311,376
1909	329,751	117,158	446,909	352,839	21,754	72,316	.043	38,434,174
1910	328,954	141,318	470,272	375,402	18,065	76,805	.044	41,383,936
1911	331,032	155,947	486,979	391,995	10,764	84,220	.045	43,828,110
1912	339,646	141,248	480,894	392,517	11,572	76,805	.045	43,280,460
1913	330,593	131,867	462,460	411,878	13,223	37,359	.044	40,696,480
1914	383,903	158,219	542,122	512,794	7,639	21,689	.039	42,285,516
Total	8,217,984	3,219,266	11,437,250	9,470,055	1,967,195		.044	1,007,583,188

[a] Since the publication of the prices given in the prefatory note, the prices for lead have been carried out in most instances to tenths of a cent for the purposes of this table.
[b] Desilverized soft lead is included; for quantity see page 805.
[c] Antimonial lead is excluded; for quantity see page 806.
[d] Desilverized soft lead is excluded.
[e] Including also lead from foreign base bullion for 1891–1905, inclusive.
[f] Included in lead from foreign ore prior to 1906.
[g] Estimated.

PRODUCTION BY STATES.

The following table, showing the production of lead by States, is compiled from figures collected by the United States Geological Survey. The compilation was made from smelter reports, and the figures represent the content of the ores and not the actual recovery, which is the quantity available for consumption. The latter quantity, termed "merchant lead," may be estimated from the figures of lead content by deducting therefrom a proper allowance for losses in smelting, desilverizing, and refining.

Production of lead by States, 1894–1905, in short tons.

Year.	Argentiferous lead.										Soft lead.
	Colorado.	Utah.	Montana.	Idaho.	California.	Arizona.	New Mexico.	Washington.	Nevada.	Other Western States.	Mississippi Valley.
1894	50,613	23,190	9,637	33,308	478	1,480	2,973	.....	2,254	150	46,300
1895	46,984	31,305	9,802	31,638	949	2,053	3,040	.....	2,583	381	53,596
1896	44,803	35,578	11,070	46,662	691	1,165	3,461	.....	1,173	1,006	51,887
1897	40,576	40,537	12,930	58,627	383	2,184	9,123	.....	959	638	56,542
1898	57,352	39,299	10,745	59,142	482	2,224	5,797	.....	4,714	1,349	54,469
1899	70,308	29,987	10,227	52,154	487	3,377	4,856	.....	3,388	862	54,444
1900	82,137	48,044	.....	85,444	520	.....	.....	.....	.....	.....	.....
1901	73,265	49,870	5,791	79,654	381	4,045	1,124	.....	1,873	1,029	67,172
1902	51,833	53,914	4,438	84,742	175	599	741	1,457	1,269	2,184	79,445
1903	45,554	51,129	3,303	99,590	55	1,493	613	538	2,237	1,765	86,597
1904	51,884	56,470	3,635	108,854	163	1,499	1,363	622	1,873	41	92,275
1905	56,638	44,996	2,207	99,027	116	2,091	1,232	56	2,206	101	104,058

The closer distribution of the lead production among the States from which the ore was derived, which was begun in 1906, has necessitated the separate table which follows. The production of refined lead can with difficulty be apportioned according to sources of ore, owing to the fact that lead refiners treat smelted products whose origin may, as in custom refining, be unknown to them, the identity of the ore and thus its original source being preserved only so far as the smelter. Accordingly, this table, showing sources of lead smelted or refined in the United States, is based as far as possible on smelter figures. It includes "pig lead" reported by all known smelters running on Mississippi Valley or southern lead ores, and "work lead" produced at all other lead smelters in this country. The greater part of the product reported by smelters operated in conjunction with refineries is in terms of refined lead. A like part of the antimonial lead is thus eliminated from the "work lead" produced and appears only in the figures of production of antimonial lead. No lead ore from the United States was treated elsewhere during the period covered by the table.

Sources of primary lead smelted or refined in the United States, 1906–1914, in short tons.

Source of ore.	1906	1907	1908	1909	1910	1911	1912	1913	1914
Domestic ore:									
Alaska	8	.....	3	69	75	51	45	6	.....
Arizona	2,884	2,418	1,464	1,507	948	3,428	3,891	4,901	5,602
Arkansas	.....	15	.....	14	.....	15	.....	.....	52
California	432	938	515	977	1,207	615	811	3,294	3,698
Colorado	50,497	52,552	28,729	30,865	38,542	30,442	37,039	42,840	41,198
Idaho	117,117	123,292	98,464	103,747	109,951	117,335	127,780	137,802	177,827
Illinois	572	498	362	273	263	308	513	619	427
Iowa	270	225	110	15	.....	.....	.....	.....	34
Kansas	1,932	1,798	2,293	2,763	1,308	2,522	1,937	1,504	1,043
Kentucky	44	75	.....	.....	50	.....	91	16	16
Missouri	111,075	122,856	122,451	141,105	161,659	182,203	162,610	152,430	194,275
Montana	2,485	2,145	2,320	1,451	1,943	2,484	2,517	3,256	4,386
Nevada	1,669	3,480	3,796	4,792	2,246	1,082	5,699	6,142	5,996
New Mexico	640	2,047	586	1,350	1,890	1,371	2,511	1,821	741
North Carolina	.....	.....	.....	.....	2	35	34	10	.....
Oklahoma	.....	404	1,409	2,268	1,805	1,925	2,500	3,214	3,916
Oregon	.....	5	7	7	.....	11	21	37	17
South Dakota	.....	.....	13	.....	8	33	12	7	2
Tennessee	11	16	.....	.....	.....	.....	.....	.....	.....
Texas	25	12	42	44	36	57	30	108	89
Utah	56,260	55,540	42,455	66,648	60,605	54,933	60,664	71,069	88,976
Virginia	.....	83	13	.....	87	400	85	878	143
Washington	46	341	391	120	339	612	53	9	2
Wisconsin	1,753	3,573	4,013	3,252	3,909	3,966	3,301	2,639	1,818
Undistributed	380	896	36	317	101	48	120	63	99
Zinc residues	2,053	1,890	1,290	1,735	2,237	1,987	3,131	3,765	4,125
Total	350,153	375,099	310,762	363,319	389,211	405,863	415,395	436,430	534,482
Foreign ore:									
Africa	.....	288	.....	3,150	3,310	582	1,774	5,976	2,942
Canada	7,238	2,607	162	66	25	122	29	16	2
Central America	112	23	12	20	3	28	.....	.....	.....
Mexico	21,435	20,204	10,145	16,944	11,704	7,333	7,407	4,512	2,386
South America	.....	919	1,186	1,536	2,996	2,677	2,332	2,617	1,821
Other foreign	18	.....	4	38	27	22	30	102	488
Foreign base bullion:									
Canada	.....	2,716	179	1,500	.....	.....	.....	.....	.....
Mexico	39,743	34,251	73,210	70,816	76,805	84,220	76,805	37,359	21,689
Total	68,546	61,008	84,898	94,070	94,870	94,984	88,377	50,582	29,328
Grand total	418,699	436,107	395,660	457,389	484,081	500,847	503,772	487,012	563,810

SOFT LEAD.

The lead ores of the Mississippi Valley are almost free from silver, and the lead produced from them is known as "soft lead." A little lead ore derived from Washington and other Western States is also of this character. With one exception, the smelters running exclusively on these soft-lead ores do not desilverize their product. Their output is shown in the "soft-lead" column of the general table of refined lead production for 1720–1914, which is given on a preceding page. However, considerable quantities of the soft-lead ores have been annually smelted by the silver-lead smelters, and, in addition, since 1904 one of the Mississippi Valley smelters has regularly desilverized its product. This desilverized soft lead, for the years prior to 1906, has not been kept separate from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted has been recorded since 1894. Since 1906 the quantity of soft lead produced by each State has been recorded, as shown in the tables below. In the table immediately following, the output of the soft-lead smelters is given in the first column, and the lead content of soft-lead ores smelted and desilverized is given in the second column. For the years 1904 and 1905 a portion of the quantity given in the second column represents lead content of ore, and a

portion is refined lead. From 1906 to the present the only quantity given is that of refined lead.

In order to give a fair notion of the annual quantity of refined pig lead recovered from soft-lead ores, the lead recovered from such ores by the silver-lead smelters has been estimated at the rate of recovery used in the official reports for those years. Even so, the figures do not give the total quantity of lead recovered from soft-lead ores. To give the total there must be taken into account the lead recovered in the form of pigments, as these are made from soft-lead ores. (See p. 807.) On this basis the soft lead recovered in both 1913 and 1914 constituted 40 per cent of the total domestic production of refined lead plus domestic lead in pigments, as compared with 44 per cent in 1912 and with 49.5 per cent in 1911.

Production of soft lead in the United States, 1894–1914, in short tons.

Year.	Undesilverized.	Desilverized.		Total soft lead.
		Lead content of ore.	Recovered lead.	
1894	37,686	[a] 8,614	[b] 8,097	[b] 45,783
1895	39,890	[a] 13,706	[b] 12,884	[b] 52,774
1896	43,537	[a] 8,350	[b] 7,849	[b] 51,386
1897	43,553	[a] 12,989	[b] 12,210	[b] 55,763
1898	42,779	[a] 11,688	[b] 10,987	[b] 53,766
1899	40,566	[a] 13,878	[b] 13,045	[b] 53,611
1900	48,021	[a] 11,500	[b] 10,810	[b] 58,831
1901	57,898	[a] 9,274	[b] 8,718	[b] 66,616
1902	74,050	[a] 5,395	[b] 5,071	[b] 79,121
1903	83,444	[a] 3,153	[b] 2,961	[b] 86,408
1904	89,169	[c] 5,320	[b] 5,165	[b] 94,334
1905	85,455	[c] 18,603	[b] 18,556	[b] 104,011
1906	90,860	.....	25,000	115,860
1907	99,801	.....	29,829	129,630
1908	101,012	.....	29,869	130,881
1909	117,158	.....	32,532	149,690
1910	141,318	.....	27,952	169,270
1911	155,947	.....	35,667	191,614
1912	141,248	.....	29,789	171,037
1913	131,867	.....	29,433	161,300
1914	158,219	.....	43,506	201,725

[a] Lead content of ores smelted and desilverized.
[b] Estimated recovery of lead from lead content of ore.
[c] In part lead content of ores, in part refined lead.

The table below shows the production of soft pig lead, by States, for the period 1906–1914, which is as far back as the records of the individual production of the Mississippi Valley States are available. The figures include both plain and desilverized soft lead, but do not include the lead content of pigments.

Production of soft pig lead in the United States in 1906–1914, by States, in short tons.

Source of ore.	1906	1907	1908	1909	1910	1911	1912	1913	1914
Arkansas	.....	15	.....	14	.....	15	.....	.....	52
Illinois	572	498	362	273	263	308	513	619	427
Iowa	270	225	110	15	.....	.....	.....	.....	34
Kansas	1,932	1,798	2,293	2,763	1,308	2,522	1,937	1,504	1,043
Kentucky	44	75	.....	.....	50	.....	91	16	16
Missouri	111,075	122,856	122,451	141,105	161,659	182,203	162,610	152,430	194,275
Oklahoma	.....	404	1,409	2,268	1,805	1,925	2,500	3,214	3,916
Tennessee	11	16	.....	.....	.....	.....	.....	.....	.....
Virginia	.....	83	13	.....	87	400	85	878	143
Washington	19	87	230	.....	189	275	.....	.....	.....
Wisconsin	1,753	3,573	4,013	3,252	3,909	3,966	3,301	2,639	1,819
Undisturbed	184	.....	.....	.....	.....	.....	.....	.....	.....
Total	115,860	129,630	130,881	149,690	169,270	191,614	171,037	161,300	201,725

ANTIMONIAL LEAD.

The production of antimonial lead from argentiferous-lead ores derived from all sources, as reported by all lead refineries operating in this country, is shown in the following table, the earlier years being estimated from the desilverized-lead output:

Production of antimonial lead in the United States from 1871 to 1914, in short tons.[1]

1871	30	1887	4,070	1903	9,579
1872	160	1888	4,540	1904	11,001
1873	600	1889	4,610	1905	10,995
1874	850	1890	3,910	1906	10,546
1875	1,050	1891	4,043	1907	9,910
1876	1,130	1892	5,039	1908	13,629
1877	1,520	1893	5,013	1909	12,896
1878	1,930	1894	5,440	1910	14,069
1879	1,940	1895	6,060	1911	14,078
1880	2,100	1896	7,507	1912	13,552
1881	2,590	1897	8,867	1913	16,665
1882	3,110	1898	8,473	1914	16,667
1883	3,660	1899	6,345		
1884	3,600	1900	9,906	Total	288,165
1885	3,220	1901	10,656		
1886	3,440	1902	9,169		

Production of antimonial lead in the United States, 1907–1914, in short tons.

Year.	From domestic ore.	From foreign ore.	Total.	Value.	Antimony content.		Lead content, by difference.
					Quantity.	Percentage.	
1907			9,910	$1,322,985	1,561	15.8	8,349
1908			13,629	1,264,771	2,440	17.9	11,189
1909	8,889	4,007	12,896	1,231,019	2,360	18.3	10,536
1910	10,140	3,929	14,069	1,338,090	2,229	15.8	11,840
1911	9,636	4,442	14,078	1,380,556	2,254	16.0	11,824
1912	8,549	5,003	13,552	1,311,348	1,949	14.4	11,603
1913	14,667	1,998	16,665	1,591,854	2,508	15.0	14,157
1914	15,475	1,192	16,667	1,572,167	2,693	16.2	13,974
Average composition, by percentage						16.1	83.9

For further details of the production and consumption of antimony in the United States, the reader is referred to the chapter on antimony in this volume.

LEAD PIGMENTS.

In addition to the leaded zinc oxide and zinc-lead oxide pigments, which are noted more particularly in connection with the production of zinc pigments, there are two lead pigments which are produced directly from ore, namely, sublimed white lead and sublimed blue lead. Sublimed white lead consists of lead sulphate 75 per cent, lead oxide 20 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, with small proportions of lead sulphide, lead sulphite, and zinc oxide. Zinc-lead oxide contains from 46 to 50 per cent of lead

[1] Estimates for 1871–1891 and for 1894–1895 based on the quantity of desilverized lead as described on page 801.

sulphate, from 52 to 46 per cent of zinc oxide, and a small quantity of zinc sulphate. Leaded zinc oxide may vary from 4 to 20 per cent in lead sulphate, the remainder being zinc oxide, with a small portion of zinc sulphate.

The lead content of the annual production of these pigments is shown in the following table:

Lead content of pigments, 1907–1914, in short tons.

1907	7,099	1911	7,678
1908	8,278	1912	10,323
1909	7,292	1913	10,998
1910	7,603	1914	11,914

SECONDARY LEAD.

Important sources of lead are skimmings, drosses, old metal, and alloys, as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral portion of the lead industry. This business is mostly carried on at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. In such cases it has been noted on the reports of the smelters to the Survey, and to that extent the production of secondary lead has always been taken into account. Since 1907, however, statistics have been collected from the secondary refineries, for the first two years by the writer, and for the last five years by J. P. Dunlop, also of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged and the number of firms reporting was increased from 44 to over 100, with the result that the figures of production for later years show a great increase. The product of such secondary refineries is of two classes—pig lead and lead in alloys. In the latter case the lead may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by addition of the requisite metal.

Production of secondary lead in the United States, 1907–1914, in short tons.

	1907	1908	1909	1910	1911	1912	1913	1914
Pig lead	10,153	7,858	18,360	29,492	27,389	30,266	33,104	29,337
Lead in alloys	15,508	10,543	23,327	25,930	26,895	36,902	39,730	31,725
Total recovered lead	25,661	18,401	41,687	55,422	54,284	67,168	72,834	61,062

COMPARISON OF TOTALS BASED ON SMELTER RETURNS AND ON THE MINES REPORTS.

The foregoing figures of the production of metallic lead by the respective States are compiled from reports of individual lead smelters and refineries. For several years statistics of the production of the more valuable metals in the Western States have been obtained by the Survey from reports of individual mines. In 1906 the same method was followed in the Eastern States, and in 1907 the plan was extended to take in the whole country. In order to put the smelter

production on the same basis as the mine figures, all the lead which was produced as pigments directly from ore is added to the production of metallic lead. The lead recovered from secondary sources is excluded from these totals, as it has already been reckoned once as pig lead. These facts must be borne in mind in comparing this table with the preceding tables. The totals obtained by each method for the last eight years are compared in the following table:

Comparison of totals compiled from smelter and from mine returns, 1907–1914, in short tons.

	Totals compiled from smelter reports.	Totals compiled from mine reports.	Smelter excess.	Mine excess.
1907	382,198	375,013	7,185	.....
1908	319,040	336,404	.....	17,364
1909	370,611	398,036	.....	27,425
1910	396,814	395,313	1,501	.....
1911	413,541	441,160	.....	27,619
1912	424,666	457,365	.....	32,699
1913	447,428	500,188	.....	52,760
1914	546,396	522,864	23,532	.....
Total	3,300,694	3,426,343	.....	125,649

The smelter totals represent actual recovery and are found by summing up the total production reported by all companies and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter totals, making allowance in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent discrepancies. The causes of these discrepancies fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter until the succeeding year, and, unless balanced by an equivalent lag from the preceding year, will thus lead to an apparent "mine excess." Near the close of 1911 there were reports in the mining journals of the accumulation of 30,000 tons of lead ore at the Tooele smelter then under construction, but which did not blow in until 1912. The lead content of this ore appears as "mine excess" in 1911. If through accident, business depression, or otherwise the mines close down, the smelters largely consume their ore stocks,

which results in an apparent "smelter excess." The second source of difference is found in error in the mine totals in the arbitrary calculation of metal content from assay. The dry assay in vogue in the Western States gives results uniformly too low. A decision of the United States circuit court (T. D. 21653) recognizes a differential of 1.5 per cent between the dry assay and chemical analysis, and in actual practice the discrepancy is probably even greater than that figure. Lastly, there is not taken into account in these totals, except in certain of the Western States, the loss in smelting, ranging from 2 to 5 per cent in treating easily reducible ores and up to 10 or more per cent in the more refractory ores. Losses running over 20 per cent have been claimed in smelting ores running high in antimony and arsenic. Lag being left out of account, the totals would normally show a mine excess equal to this smelting loss. Any discrepancy which appears in the table may reasonably be ascribed to one or more of these items. In the long run, barring error and allowing for smelting losses and exportation of ore, the "mine excess" will be balanced by equivalent "smelter excess."

By referring to the table comparing the mine and smelter totals, it will be seen that three times during the last eight years the production of lead by the mines has been less than the output of the smelters. In the other years the mine production has been considerably in excess. The total output of merchant lead, soft lead, and lead in pigments by the smelters during the eight years was 3,300,694 tons, while the output of the mines for the same period was 3,426,343 tons, the excess of mine production over smelter production being 125,649 tons.

These figures allow the making of an estimate of smelting losses. The total production of soft pig lead for the eight years is 1,305,147 tons, and of lead in pigments 71,185 tons, a total of 1,376,332 tons of soft lead. In smelting this soft lead the loss was not far from 2 per cent, a total of 28,088 tons. If this be deducted from the mine excess for the period, it leaves 97,561 tons as the loss in smelting argentiferous ores, which amounts to a little over 5 per cent. This does not include the loss in refining, probably not over 1 per cent. Furthermore, allowance for smelting losses has been made to a certain extent in some of the mines reports of the Western States, so that the average loss in smelting and refining argentiferous lead since 1907 seems to be somewhat over 6 per cent. Stocks of lead ore at smelters are probably somewhat larger now than they were at the beginning of 1907, but this difference must be very small when compared to the large quantity of lead smelted in the eight years. The difference in stocks would operate to reduce slightly the estimate of smelting loss, as given above.

RESOURCES.

For several years there has been given in this report a table showing for each lead-producing State the total quantity of lead-bearing ores produced, and the output of each kind of lead-bearing ore, as well as the lead content. This table will hereafter be found in the chapter of Mineral Resources of the United States entitled "Metals and ores."

There has also been given here a very brief summary of the lead-mining operations in each lead-producing State. This review will hereafter be discontinued, as the data are given in greater detail in

the various mines reports by States, and in its stead there is given the following table showing the annual mine production of lead by States for the period 1907–1914. Statistics of mine production of lead are not available for all the States before 1907. These figures of mine production are obtained from the mine operators and not from the smelters, as explained on a previous page.

Mine production of lead by States, 1907–1914, in short tons.

	1907	1908	1909	1910	1911	1912	1913	1914
Alaska	.....	.....	19	28	24	.....	18	.....
Arizona	2,330	1,504	1,549	1,348	5,137	3,403	8,072	7,502
Arkansas	12	15	24	63	64	31	18	41
California	1,313	619	751	1,435	699	572	1,757	2,126
Colorado	42,703	26,100	36,084	38,036	34,840	37,621	43,949	37,106
Idaho	116,912	103,414	107,993	114,129	136,278	142,093	158,936	174,263
Illinois	830	399	295	373	964	1,282	959	717
Iowa	242	51	36	20	60	63	65	.....
Kansas	2,555	2,518	1,300	2,412	2,859	2,371	2,427	1,409
Kentucky	34	.....	10	41	.....	106	22	16
Missouri	138,675	144,459	159,435	161,016	178,868	177,069	176,116	192,612
Montana	1,874	2,298	1,492	2,053	3,216	3,723	5,468	4,828
Nevada	3,136	3,623	4,920	2,436	1,632	9,750	8,172	6,405
New Mexico	1,905	437	2,515	2,160	1,483	2,747	1,973	882
North Carolina	.....	.....	.....	.....	.....	46	.....	.....
Oklahoma	532	1,781	3,427	2,888	2,501	3,388	6,228	7,556
Oregon	.....	1	.....	.....	.....	20	44	8
South Dakota	.....	12	59	7	32	11	5	2
Texas	12	33	46	33	61	33	113	75
Utah	57,969	44,389	74,243	61,662	68,248	70,156	83,063	85,662
Virginia	70	38	.....	99	417	235	816	127
Washington	410	575	144	661	424	64	101	33
Wisconsin	3,499	4,138	3,694	4,413	3,353	2,581	1,866	1,494
Total	375,013	336,404	398,036	395,313	441,160	457,365	500,188	522,864

METALLURGY.

CONCENTRATION AND SEPARATION.

The problems of concentration and separation of lead ores do not differ essentially from those concerning zinc ores or the complex sulphide ores of lead and zinc. The various adaptations of the principles of flotation and of electrostatic separation to such ores have been discussed in the chapters on zinc in Mineral Resources of the United States for 1908 and for 1910–1914, to which the reader is referred.

Mention should be made here, however, of the installation of flotation units in almost every one of the concentration plants connected with the lead mines of the disseminated lead districts of southeastern Missouri and of the Coeur d'Alene region of Idaho, the two most important lead districts of the country. The increased saving of metallic content by flotation methods must result in a material increase in the production of lead in those districts.

SMELTING.

LEAD SMELTERS AND REFINERIES IN 1914.

In the following list the attempt has been made to give all the lead smelters and refineries in existence or under construction in North America in 1914. The plants which produced in 1914 are given in ordinary type; those which were idle are listed in italics.

Lead smelters and refineries in North America in 1914.

UNITED STATES.

Arizona:
Mowry—*Consolidated Mines, Smelter & Transportation Co.*[1]
California:
Keeler—*Four Metals Mining & Smelting Co.*[1]
Needles—Needles Mining & Smelting Co.[2]
Selby—Selby Smelting & Lead Co.[3] Refinery also.
Colorado:
Denver—Globe plant, American Smelting & Refining Co.
Durango—Durango plant, American Smelting & Refining Co.
Georgetown—*Western Metals Co.* Malm dry chlorination process.
Leadville—Arkansas Valley plant, American Smelting & Refining Co.
Pueblo—Pueblo plant, American Smelting & Refining Co.
Salida—The Ohio & Colorado Smelting & Refining Co.
Idaho:
Clayton—Red Bird Smelting Co.
Enaville—*North Fork Smelting & Mining Co.*
Ponderay—*Idaho Smelting & Refining Co.*[1]
Sea Foam—*Greyhound Mining & Milling Co.*
Illinois:
Aurora—Aurora Metal Co.[4]
Chicago—Goldsmith Bros.' Smelting & Refining Co.[4]
Chicago—Great Western Smelting & Refining Co.[4]
Chicago—National plant, American Smelting & Refining Co. Refinery only.
Collinsville—St. Louis Smelting & Refining Co.[5] Refinery also.
Federal—Federal Lead Co.[3]
Granite City—Hoyt Metal Co.[4]
Indiana:
East Chicago—International Lead Refining Co.[6] Refinery only.
East Chicago—U. S. Reduction Co.[4]
Grasselli—United States Metals Refining Co.[2] Refinery only. Betts electrolytic process.
Iowa:
Dubuque—*J. W. Watters.*[1]
Kansas:
Galena—Galena Smelting & Manufacturing Co.
Missouri:
Desloge—Desloge Consolidated Lead Co.
Granby—Granby Mining & Smelting Co.
Herculaneum—St. Joseph Lead Co.
Joplin—Picher Lead Co.
Valle Mines—*Valle Mining Co.*[1]
Webb City—Webb City Smelting & Manufacturing Co.
Montana:
Cooke—*Western Smelting & Power Co.*
East Helena—East Helena plant, American Smelting & Refining Co.
Helena—Northwestern Metals Co. Dry chlorination process.
Nebraska:
Omaha—Omaha & Grant Smelting Co.[7] Refinery only. Betts electrolytic process.
Nevada:
Nelson—*Santa Barbara Searchlight Mining Co.*[1]
Spruce—*Black Forest Mines & Smelting Co.*[1]
New Jersey:
Newark—Balbach Smelting & Refining Co. Refinery also.
Perth Amboy—Perth Amboy plant, American Smelting & Refining Co. Refinery also.
New Mexico:
Deming—*National Mining & Smelting Co.*[1]
Pennsylvania:
Carnegie—Pennsylvania Smelting Co. Refinery also.

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[1] Not operated for several years.
[2] Subsidiary of United States Smelting, Refining & Mining Co.
[3] Subsidiary of American Smelters Securities Co.
[4] Smelters of secondary materials, but treating some lead ores.
[5] Subsidiary of National Lead Co.
[6] Subsidiary of International Smelting & Refining Co.
[7] Subsidiary of American Smelting & Refining Co.

Texas:
El Paso—Kansas City Consolidated Smelting & Refining Co.[1]
Utah:
Midvale—United States Smelting Co.[2]
Murray—Murray plant, American Smelting & Refining Co.
Silver City—*Tintic Smelting Co.*[3]
International—International Smelting Co.
Washington:
Keller—*Keller & Indiana Consolidated Smelting Co.*[3]
Northport—Northport Smelting & Refining Co. Two lead stacks under construction.
Wisconsin:
Dodgeville—*Blue Mounds Mining & Smelting Co.*[3]
Waukesha—*Northern Smelting Co.*[3]

CANADA.

British Columbia:
Trail—Consolidated Mining & Smelting Co. of Canada (Ltd.). Refinery also. Betts electrolytic process.
Ontario:
Kingston—North American Smelting Co. (Ltd.).

MEXICO.

Aguascalientes:
Aguascalientes—American Smelting & Refining Co.
Chihuahua:
Chihuahua—American Smelting & Refining Co.
Uruáchic—Uruáchic Mining & Smelting Co. (Ltd.).
Coahuila:
Saltillo—Mazapil Copper Co. (Ltd.).
Torreon—Compañía Metalúrgica de Torreón.
Durango:
Asarco (Velardena)—American Smelters Securities Co.
Mapimi—Compañía Minera de Penoles.[4]
Guerrero:
Campo Morado—*Reforma Mining & Milling Co.*[3]
Nuevo Leon:
Monterey—American Smelting & Refining Co.
Monterey—Compañía Minera, Fundidora y Afinidora, S. A.[5] Refinery also.
San Luis Potosi:
Matehuala—American Smelters Securities Co. (National Metallurgical Co.)
San Luis Potosi—Compañía Metalúrgica Mexicana.
Sonora:
Guaymas—*Pacific Smelting & Refining Co.*[3,6]. (*Mexican-American Smelting & Refining Co. (Ltd.).*
Ures—*Yaqui Smelting & Refining Co., S. A.*[3] *Refinery also.*
Zacatecas:
Chalchihuites—*National Smelting Co.*[3]

SMELTER CHANGES.

At the end of 1914 the National refinery of the American Smelting & Refining Co. at Chicago was closed and dismantled. A portion of the equipment was retained to try out a process of recovering the zinc content of zincky slags.

The Balbach Smelting & Refining Co. transferred all lead smelting and refining operations from the old plant in Newark to the newly completed plant on Newark Bay.

Two of the large lead-mining companies of the Coeur d'Alene district are establishing their own smelting plants. The interests controlling the Hercules Mining Co. have purchased the old copper smelter at Northport, Wash., and are adding two lead furnaces. The

[1] Subsidiary of American Smelting & Refining Co.
[2] Subsidiary of United States Smelting, Refining & Mining Co.
[3] Not operated for several years.
[4] Subsidiary of American Metal Co.
[5] Plant destroyed during Mexican civil war, 1914.
[6] Built several years ago; never blown in.

Bunker Hill & Sullivan Mining & Concentrating Co. is reported to have set aside liberal funds for building a modern smelter. The site has not been definitely selected, but it will most likely be in the vicinity of Kellogg, Idaho. A few years ago the Bunker Hill & Sullivan Co. purchased parts of the plant of the Western Metals Co. (using the Malm dry chlorination process), at Georgetown, Colo. These were moved to Wardner, Idaho, and tried out. It was later announced in the local press that a process along wholly different lines had been worked out, which was very successful. There has been no mention of the process to be employed in the new smelter, and presumably the usual pyrometallurgical practice will be followed.

The Northwestern Metals Co. completed at Helena, Mont., a 100-ton plant costing $750,000, which uses the dry-chlorination process. Complex sulphide ores are treated, the metals dissolved as chlorides, gold, silver, lead, and copper, are precipitated by zinc and are recovered by the usual process of lead smelting. The zinc chloride in solution is evaporated, fused, and the zinc recovered by electrolysis. The very similar plant erected at Georgetown, Colo., several years ago was, through untoward circumstance, never brought to completion and practical operation. It is fortunate that the new process is to be tried out now when the metals are at such prices that difficulties will involve delay but not financial discouragement.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The following table of the production of lead in the world has been calculated from the statistics published by the Metallgesellschaft, of Frankfurt-am-Main, Germany, with the exception of the substitution of the figures collected by the United States Geological Survey for the production of the United States. It is to be noted that the production of Africa and South America is not separately given in the table. As shown on a preceding page, considerable lead has been smelted and refined in the United States in the last seven years from ores produced in those countries.

The world's production of lead, 1906–1913, in short tons.

Country.	1906	1907	1908	1909	1910	1911	1912	1913
Australia	102,514	106,923	131,174	85,098	108,907	109,789	118,387	127,867
Austria-Hungary	18,078	16,975	16,094	15,432	19,290	21,605	23,589	26,565
Belgium	24,471	28,417	39,352	44,423	44,864	48,832	56,438	55,997
Canada	26,235	13,338	18,849	22,928	16,535	11,795	17,968	18,849
France	28,219	25,353	28,770	29,652	22,266	26,014	34,282	30,864
Germany	166,117	157,156	185,076	184,745	174,604	181,218	194,666	199,627
Great Britain	26,455	30,203	32,738	31,085	32,628	28,660	32,187	33,620
Greece	13,338	15,212	17,637	16,865	18,519	15,763	15,983	20,282
Italy	23,479	25,243	28,660	24,361	15,983	18,408	23,699	23,920
Japan	3,858	3,858	3,197	3,748	3,858	4,630	4,960	3,968
Mexico	59,524	79,366	121,253	130,071	133,048	137,347	132,276	68,343
Russia	331	110	110	882	1,323	1,102	1,102	1,102
Spain	199,406	204,918	202,052	202,823	211,531	193,013	205,799	223,767
Sweden	882	882	331	220	441	1,213	1,433	1,653
Turkey in Asia	10,582	11,464	13,007	13,338	13,999	13,668	13,779	15,322
Other countries	220	220	551	6,393	17,306	22,597	13,448	6,834
United States (domestic, refined)	336,200	352,381	311,666	352,839	375,402	391,995	392,517	411,878
Total	1,039,909	1,072,019	1,150,517	1,164,903	1,210,504	1,227,648	1,282,513	1,270,458
United States percentage of world's production	32.3	32.9	27.1	30.3	31.0	32.0	30.6	32.4

Owing to the disturbed conditions in Europe, no figures of the world's production in 1914 are available.

THE LEAD INDUSTRY AS AFFECTED BY THE WAR IN EUROPE.

The following tables of exports of lead and lead manufactures, repeating in part certain tables given elsewhere in this report and including figures later than the year to which this report pertains, are segregated here to show the effect of the war on the lead industry. Perhaps the most striking fact was the exportation of large quantities of domestic pig lead, something which had not occurred for many years and never before in such quantities.

Exports of lead from the United States by six-month periods, 1914–15, by classes, in pounds.

	1914				1915	
	January–June.		July–December.		January–June.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
FROM DOMESTIC ORE.						
Lead, pigs or bars	40,323,662	$1,511,800	77,120,238	$2,989,874	115,903,983	$4,936,730
Lead manufactures	.....	633,234	.....	385,000	.....	732,875
FROM FOREIGN ORE.						
Lead ore, content	6,724,525	245,205	.....	.....	.....	.....
Bullion, content	10,944,350	378,286	.....	.....	.....	.....
Lead, pigs and bars	.....	.....	25,421,500	913,306	34,435,599	1,041,541
Lead manufactures	.....	1,810	.....	432	.....	31
Lead used in articles exported with benefit of drawback	7,595,127	[a] 301,500	11,416,486	[a] 431,500	6,040,015	[a] 262,700
Total	.....	3,071,835	.....	4,720,112	.....	6,973,877

[a] Represents the value of the metal used in making the articles exported with benefit of drawback.

Exports of lead from the United States, by six-month periods and destination, 1914–15, in short tons.

Destination.	Pig lead.					
	January–June, 1914.		July–December, 1914.		January–June, 1915.	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
Canada	.....	28	4,082	.....	6,176	58
Great Britain	7,153	3,963	16,995	6,270	25,945	10,480
Netherlands	4,720	1,592	2,019	28	677	739
Belgium	2,101	746	560	.....	.....	.....
France	.....	.....	.....	560	8,585	1,171
Italy	.....	71	589	.....	1,560	2,030
Germany	5,141	1,681	2,241	.....	.....	.....
Russia	448	.....	6,263	5,717	7,623	1,741
Japan	.....	.....	2,247	.....	2,081	.....
Other countries	599	753	3,564	136	5,305	999
	20,162	8,834	38,560	12,711	57,952	17,218

Exports of lead from the United States, by months, 1914–15, in short tons.

Month.	Lead, pigs and bars.		
	Domestic.	Foreign.	Foreign lead used in articles exported with benefit of drawback.
1914.			
January	.....	1,363	3,798
February	.....	166	
March	5,838	246	
April	5,931	3,663	
May	2,045	2,420	
June	6,348	976	
July	10,894	1,119	5,640
August	5,486	.....	
September	2,793	923	
October	7,829	2,521	
November	8,417	5,297	
December	3,141	2,851	
	58,722	21,545	9,438
1915.			
January	6,460	3,072	3,020
February	3,820	1,778	
March	7,023	2,301	
April	19,936	5,133	
May	15,312	3,021	
June	5,401	1,913	
July	1,402	979	.....
August	3,224	5,227	.....
September	2,458	3,723	.....
October	5,787	3,284	.....

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the lead goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the lead may be withdrawn for consumption by payment of duty, or it may remain in bond for smelting and refining, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The lead entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption which are expressed in the same terms as those in which they were imported. The lead imported for consumption may be actually used in this country, or it may be manufactured into articles which are exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign lead given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse.

The two items, foreign lead exported from warehouse and foreign lead exported in manufactures with benefit of drawback, make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity this foreign lead is carried on the bonded customs warehouse records in the form in which the lead was entered until the bond is canceled. It must be clearly understood, therefore, that in the table of foreign exports of lead, on a later page, the lead there listed was not exported as lead content of ore and base bullion but as refined lead smelted and refined from them. There is no record kept of the lead in the form in which it is actually exported except for a portion of the articles manufactured from foreign lead and exported with benefit of drawback. For articles not made wholly of lead it would be useless to give weights. But each shipment on which drawback is claimed is accompanied by a manifest of the imported lead used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign lead used in manufactures exported with the benefit of drawback. For this reason the lead is given in the form in which it was imported.

The following table, taken from the reports of the Bureau of Foreign and Domestic Commerce, shows the lead remaining in warehouse at the close of each year, beginning with 1899, and also the district in which remaining. For the reasons given above, the lead is shown in the terms in which imported. For instance, a considerable part of the lead stated as remaining in ore and base bullion doubtless represents refined lead waiting at the bonded refinery for a favorable market for shipment. If this be borne in mind, the table gives a fair idea of the fluctuations of foreign stock at different times and in different localities.

Lead remaining in warehouse, 1899–1914, in pounds.

Dec. 31—	Form in which entered for warehouse.		Remaining at *a*—					
			New York.		Chicago, Ill.	El Paso, Tex.	San Francisco, Cal.	Puget Sound.
	Lead in ore and base bullion.	Pigs, bars, and old.	Newark, N. J.	Perth Amboy, N. J.				
1899	22,302,286	17,033	6,343,323	12,070,835	215,032	2,552,911	122,851	976,012
1900	42,379,270	.....	10,692,307	10,157,018	2,236,555	2,642,568	3,149,975	6,147,500
1901	33,225,677	18,808	5,927,039	7,964,931	.....	1,325,874	2,521,095	6,122,420
1902	47,817,806	59,487	8,198,289	14,176,702	4,157,558	2,949,481	3,745,809	2,073,152
1903	21,387,901	.....	5,192,823	3,850,638	3,896,471	4,079,021	3,430,526	938,422
1904	22,962,984	.....	1,629,852	7,482,560	5,999,972	6,062,072	1,732,742	46,295
1905	16,296,391	112	10,117	6,746,035	3,755,890	4,553,951	260,777	941,623
1906	11,382,998	128,812	1,743,853	3,870,951	2,736,979	229,267	306,607	2,480,817
1907	25,794,409	93,286	1,057,836	6,197,503	7,918,991	8,846,533	1,226,261	.....
1908	36,923,604	206,651	6,772,049	23,356,695	3,950,517	2,381,867	15,526	.....
1909	34,655,780	158,208	4,941,828	18,213,808	9,461,123	1,832,867	39,911	.....
1910	71,794,443	149,082	7,548,936	36,112,136	21,090,631	6,937,667	.....	.....
1911	8,869,713	93,082	2,777,692	2,308,322	954,884	2,555,733	.....	.....
1912	20,891,182	93,802	1,880,828	17,666,768	484,671	767,533	.....	.....
1913	10,620,953	.....	8,785,551		80,880	1,683,091	.....	.....
1914	15,333,064	3,837	10,309,592		94,775	4,802,961	.....	.....

a Also in 1900 at Kansas City, Mo., 1,776,137 pounds, and at Omaha, Nebr., 5,306,351 pounds; in 1901 at Denver, Colo., 9,364,318 pounds; in 1902, at Denver, Colo., 12,516,815 pounds; in 1911 at Kansas City, Mo., 273,082 pounds; in 1912 at Kansas City, Mo., 91,382 pounds; in 1913 at St. Louis, Mo., 71,431 pounds; and in 1914 at St. Louis, Mo., 125,736 pounds.

IMPORTS.

The following tables of lead and type metal imported and entered for consumption and of general imports of lead are taken from the reports and records of the Bureau of Foreign and Domestic Commerce:

Lead imported and entered for consumption in the United States, 1900–1914, in pounds.

Year.	Lead in ore.[a]		Base bullion.[b]		Pigs, bars, and old.		Sheets, pipe, and shot.		Not otherwise specified.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1900	10,209,742	$623,802	.....	.....	3,673,616	$76,141	27,945	$1,393	$877	$702,213
1901	10,324,119	272,396	.....	.....	3,604,157	88,056	56,735	2,773	1,234	364,459
1902	14,499,339	316,005	.....	.....	12,443,615	319,035	224,209	7,765	5,258	648,063
1903	41,155,130	716,128	.....	.....	8,972,635	255,135	17,008	810	1,589	973,662
1904	19,015,540	328,279	.....	.....	17,334,033	480,823	69,581	2,441	5,277	816,820
1905	49,526,990	784,548	.....	.....	10,379,753	329,209	77,668	3,813	1,139	1,118,709
1906	44,560,258	755,545	587,731	$15,635	24,882,983	960,998	346,177	17,250	4,503	1,753,931
1907	13,363,875	286,802	1,196,224	35,303	15,667,170	718,198	734,418	39,210	3,450	1,082,944
1908	2,806,524	76,746	11,415,463	251,266	5,346,290	176,363	42,377	2,026	9,843	516,244
1909	7,080,753	142,847	21,896,611	454,568	7,095,442	229,751	40,434	2,056	32,284	861,506
1910	7,998,859	198,196	16,543,167	337,223	6,776,066	212,858	39,779	1,972	4,843	755,092
1911	1,474,254	26,563	17,376,459	352,595	7,112,749	242,423	63,151	2,855	7,218	631,654
1912	935,861	24,760	22,729,467	462,559	5,191,823	110,459	31,184	2,305	5,468	605,551
1913	2,306,972	75,835	17,665,227	388,116	4,621,270	105,738	39,171	3,291	12,710	572,980
1914	5,459,961	188,749	8,904,649	301,195	575,290	12,281	62,552	2,753	81,894	504,978

[a] For period 1900–1905, inclusive, the gross weight and value of base bullion imported for consumption are also included.

[b] For the years previous to 1906 the imports of base bullion (gross weight) are not distinguished from imports of lead in ore.

Type metal imported and entered for consumption, 1899–1914, in pounds.

Year.	Type metal.		Lead content.[a]	
	Gross weight.	Value.	Pounds.	Percentage.
1899	1,110,188	$56,442	.....	.....
1900	1,032,866	51,242	.....	.....
1901	3,222,431	116,875	.....	.....
1902	6,469,971	194,394	.....	.....
1903	6,603,863	208,728	.....	.....
1904	8,143,749	221,127	6,884,423	84.5
1905	13,932,013	456,155	11,476,629	82.4
1906	19,602,471	900,608	15,896,629	81.1
1907	14,832,673	932,027	12,095,027	81.5
1908	4,110,486	156,847	3,265,815	79.5
1909	13,993,889	532,108	11,339,378	81.0
1910	13,394,199	485,493	11,176,830	84.9
1911	8,390,470	310,658	6,936,711	82.7
1912	581,411	18,668	477,006	82.0
1913	567,004	20,098	467,688	82.5
1914	1,509,538	45,373	1,322,188	87.6
Average lead content, 1904–1914	.....	.....	.....	82.1

[a] Prior to 1904 the lead content of the type metal was not given. Besides lead, the chief constituent of the type metal is antimony.

Imports of lead, in ore, base bullion, and refined, by countries, 1908–1914, in pounds.

Country.	1908	1909	1910	1911	1912	1913	1914
United Kingdom	399,569	191,243	1,874,750	401,686	279,546	404,594	245,548
Germany	695,151	2,821,967	421,377	56,286	494,237	262,132	4,529,919
Other European countries	1,699,509	1,385,616	418,669	111,189	55,356	143,293	123,085
Total from Europe	2,794,229	4,398,826	2,714,796	569,161	829,139	810,019	4,898,552
British North America	1,291,044	4,133,755	206,979	270,947	319,497	338,569	384,007
Mexico	219,567,193	215,203,714	203,290,307	172,633,479	159,455,664	95,693,439	46,282,207
South America	469,770	1,942,847	6,598,263	4,778,221	3,207,936	8,766,327	2,417,744
Other countries	26,418	2,683,950	4,394,421	1,651,544	3,309,356	8,685,612	2,694,293
Total imports	224,148,654	228,363,092	217,204,766	179,903,352	167,121,592	114,293,966	56,676,803

In the foregoing table the lead imports from Germany are shown to have greatly increased. This increase must be, under another designation, a part of the lead in ore which has heretofore come from German South Africa and has been included above under "Other countries" and which is seen to have decreased greatly. Imports from Mexico fell off over one-half from those in 1913 and are now less than one-fourth what they were in 1908–1910. As a result the whole imports of lead into the United States were less than one-half those of 1913. Of the lead imported from Mexico, 13,537,041 pounds was in ore, 32,730,320 pounds was contained in base bullion, constituting the whole imports of base bullion into the United States, and 14,846 pounds was in the form of refined lead, probably old scrap. The imports of lead in ore from Chile amounted to 2,410,825 pounds.

The following table shows the imports of lead in ore, base bullion, and pigs, bars, sheets, and old:

Imports of lead, by classes, 1907–1914, in pounds.

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total lead content.[a]
		Gross weight.	Lead content.[a]		
1907	64,815,254	76,259,828	74,594,313	18,554,899	157,964,466
1908	64,708,204	153,921,829	150,560,176	5,518,621	220,787,001
1909	71,357,868	149,852,559	146,579,779	7,152,665	225,090,312
1910	94,751,054	118,061,415	115,483,542	6,970,170	217,204,766
1911	35,686,180	141,481,852	138,952,372	5,264,800	179,903,352
1912	19,577,499	152,420,624	146,999,168	544,925	167,121,592
1913	19,883,313	96,908,170	94,327,654	82,999	114,293,966
1914	23,649,637	33,444,503	32,730,320	296,846	56,676,803

[a] Lead content of bullion for 1907–1909 estimated on the basis of average lead content of imports of base bullion in 1910.

EXPORTS.

DOMESTIC EXPORTS.

The average difference between the New York and the London lead prices for the 10 years prior to 1914 has been not far from 1½ cents per pound. This being the case, domestic lead exports should be expected only under temporary and very unusual circumstances. The practice of the Bureau of Foreign and Domestic Commerce is to

class all exports of lead articles manufactured in this country as domestic exports, whether the lead be of domestic or foreign origin. The table of exported lead and manufactures of lead of domestic production, made up from the records of the Bureau of Foreign and Domestic Commerce, and heretofore published in this report, must be duplicated in part, if not completely, in the following table of exports of manufactures with benefit of drawback. For this reason it has been decided to abandon the table of domestic exports as previously published.

In 1914, however, the price of lead at London rose above the New York price early in January and consistently remained between one-fourth and one-half cent above throughout the year. This made it possible to export domestic lead at a profit, and the decrease in lead imports from Mexico rendered it necessary to satisfy the foreign demand with domestic lead, the exports of which assumed large proportions. The movement commenced in March and by the close of the year 58,722 short tons, valued at $4,501,674, had been exported. The quantities exported per month and the destination are given in another place.

FOREIGN EXPORTS.

By foreign lead exports is meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total foreign lead exported for 15 years; but it must be borne in mind, as pointed out on a previous page, that the actual exports were not in the form shown in the table, which is the import form, but instead consisted of refined lead and lead manufactures. The quantities of lead exported from warehouse are exact, but the quantities given of lead in manufactures are subject to the waste in manufacturing.

Under the present tariff regulation, as also under the tariff of 1909, the lead that must be sent out before the bond can be canceled is that actually recovered in smelting and refining the ore and base bullion. Under the tariff of 1897 the bond was canceled when 90 per cent of the lead content of the ore or gross weight of the base bullion was shipped out. If, then, in refining base bullion more than 90 per cent of the total weight was recovered as lead, the bond would be canceled on the exportation of that 90 per cent and the excess above 90 per cent could remain in this country without payment of duty. No doubt prior to 1909 considerable foreign lead used in this country escaped duty in this wise.

Exports of foreign lead, 1900–1914, in pounds.

Year.	Exported from warehouse.							Exported in manufactures with benefit of drawback.	
	Lead content ore.[a]		Lead content base bullion.[a]		Pigs, bars, and old.		All other manufactures.	Lead content ore.	Pigs, bars, bullion, and old.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	Quantity.	Quantity.
1900...	197,795,960	$3,840,798	.....	.....	30,163	$564	$2,519	1,705,970	6,861,030
1901...	194,724,197	4,183,101	.....	.....	50,000	2,500	4,924	9,452,628	5,935,331
1902...	157,891,135	3,551,380	.....	.....	43,130	1,000	764	2,173,559	9,501,049
1903...	163,774,605	2,908,531	.....	.....	55,566	1,627	7,799	2,339,106	9,331,256
1904...	167,686,199	2,844,403	.....	.....	87,471	3,937	32,467	2,946,810	10,445,974
1905...	117,263,861	2,378,327	.....	.....	1,647,523	54,993	7,846	3,584,610	12,700,971
1906...	94,449,751	2,303,382	.....	.....	48,680	1,138	2,825	3,447,478	8,536,424
1907...	102,847,310	2,416,082	.....	.....	47,078	2,169	3,033	1,826,756	14,709,149
1908...	153,657,371	3,068,427	.....	.....	56,000	1,500	32,026	9,392,428	9,114,209
1909...	118,325,560	2,002,644	[b] 53,817,393	$1,036,080	11,447	487	697	2,992,967	6,598,149
1910...	22,508,090	248,220	117,045,333	2,262,057	19,507	703	870	6,592,294	11,008,604
1911...	39,276,820	730,247	151,986,265	3,093,290	12,311,102	244,037	1,504	674,621	23,485,929
1912...	12,796,703	219,859	116,907,305	2,478,256	107,170	3,826	2,121	150,617	22,584,221
1913...	11,721,714	271,985	77,253,891	1,827,538	111,506	4,851	3,422	74,628	19,484,345
1914...	6,724,525	245,205	10,944,350	378,286	25,421,500	913,306	2,242	4,153,018	14,722,213

[a] Prior to June, 1909, exports of foreign lead from warehouse do not distinguish between lead content of ore and gross weight of base bullion.
[b] For six months, July–December, 1909.

CONSUMPTION.

In statements of consumption of lead in these reports prior to 1907 it was the custom to take into account the smelter stocks of lead at the beginning and at the close of the year. It is not to be denied that for the individual year this gives closer figures. It is just as true that account of trade stocks should also be taken to arrive at accurate results; but this is manifestly outside the scope of this Survey. It has been found impossible to obtain a statement of stocks from one large producer since 1906; hence consumption has been calculated without reference to domestic stocks. A very considerable part, however, amounting to between one-fourth and one-fifth of the lead smelted and refined in this county, is lead of foreign origin smelted in bond, and it is possible to obtain the stocks of this portion, since they are reported annually by the Bureau of Foreign and Domestic Commerce as "merchandise remaining in warehouse at close of year." A certain element of error is introduced by the fact that the imports, the exports, and the warehouse stocks, as given, include lead in both ore and base bullion. So far as imports are concerned, the relative quantities of lead in ore and of base bullion are shown, on a preceding page, in the table entitled "Imports of lead, by classes," based upon the records of the Bureau of Foreign and Domestic Commerce, and corroborated in the preceding table giving the "sources of primary lead smelted or refined in the United States," based upon smelter reports. For exports and warehouse stocks no such division can be made, because the classes used therein represent the condition of the metal when imported and do not change with the reduction of the metal in bond. Nevertheless, it is deemed advisable to use warehouse stocks as giving a better estimate of con-

sumption. It is necessary, therefore, to include all classes of lead imports as well as all classes of lead exports.

In the following table "lead" includes all kinds—lead in ore, base bullion, pigs, bars, and old. The figures of domestic production are based upon the returns by the smelters; all other figures are from the records of the Bureau of Foreign and Domestic Commerce. Decrease by liquidation covers losses in smelting and refining in bond and other corrections. Because warehouse stocks are used in lieu of smelter stocks the result given below is lead "available for consumption." The "apparent consumption" of previous reports would be this quantity increased or diminished by the increase or decrease of domestic stocks during the year.

Primary lead available for consumption in the United States, 1908–1914, in short tons.

	1908	1909	1910	1911	1912	1913	1914
Supply:							
Stock in bonded warehouse Jan. 1	12,944	18,565	17,405	35,972	4,481	10,492	5,310
Imports—							
For consumption	9,805	18,036	15,359	13,281	14,146	11,980	7,386
For warehouse	102,241	96,145	93,249	76,671	69,414	45,165	20,952
Production from domestic ores	311,666	352,839	375,402	391,995	392,517	411,878	512,794
Apparent supply	436,656	485,585	501,415	517,919	480,558	479,515	546,442
Withdrawn:							
Exports of foreign lead—							
From warehouse	76,857	86,077	69,786	101,227	64,906	44,544	21,545
In manufactures, with benefit of drawback	9,254	4,796	8,800	12,080	11,320	9,779	9,438
Exports of domestic lead							58,722
Decrease by liquidation	13,425	8,643	7,661	14,812	5,692	419	56
Stock in bonded warehouse Dec. 31	18,565	17,405	35,972	4,481	10,492	5,310	7,668
Total withdrawn	118,101	116,921	122,219	132,600	92,410	60,052	97,429
Available for consumption	318,555	368,664	379,196	385,319	388,148	419,463	449,013

For facility of comparison of consumption in the United States with that of the world, the consumption of the former has been calculated with and without stocks for a period of years, as shown in the following table. Consumption of lead, as shown in the second column, means the production of refined lead minus excess of exports over imports or plus excess of imports over exports. Additions made to stock during the year will thus appear as consumed, but as such stocks are apt to go into the market within the next year and to cut down the apparent consumption to that extent, they must compensate in the long run, leaving an accurate average measure of the consumption. The statistics of consumption of foreign countries as given in the table are taken from the estimates of the Metallgesellschaft, etc., which are also compiled without regard to stocks. In the following table, the first column gives, for the sake of comparison, the consumption with stocks taken into consideration; the remainder of the table disregards stocks. In neither column showing the United States consumption is the production of secondary lead taken into account.

Owing to the war no statistics of production or consumption of lead in European countries have been published for 1914. The tables of world consumption close, therefore, with 1913.

World's consumption of pig lead, exclusive of secondary lead, 1898–1913, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States, percentage.
1898	227,452	225,177	651,018	876,195	25.7
1899	226,315	230,294	652,782	883,076	26.1
1900	269,302	279,172	667,002	946,174	29.5
1901	271,934	284,126	663,805	947,931	29.9
1902	332,484	300,643	685,079	985,722	30.5
1903	300,167	284,556	701,945	986,501	28.8
1904	319,543	320,330	719,471	1,039,801	30.8
1905	347,015	343,682	736,998	1,080,680	31.8
1906	376,337	376,981	705,142	1,082,123	34.8
1907	[a] 360,715	367,903	710,102	1,078,005	34.1
1908	[a] 318,555	324,176	833,293	1,157,469	28.0
1909	[a] 368,664	367,504	814,708	1,182,212	31.1
1910	[a] 379,196	397,763	811,292	1,209,055	32.9
1911	[a] 385,319	353,828	865,086	1,218,914	29.0
1912	[a] 388,148	394,159	885,587	1,279,746	30.8
1913	[a] 419,463	414,281	876,218	1,290,499	32.1

[a] See preceding table, "Primary lead available for consumption in the United States" in 1908–1914.

Consumption of lead, stocks and secondary lead disregarded, in 1907–1913, by countries, in short tons.

Country.	1907	1908	1909	1910	1911	1912	1913
Australia	5,952	8,501	5,401	7,937	10,031	11,133	10,582
Austria-Hungary	27,778	31,906	34,171	34,722	39,903	41,667	39,132
Belgium	36,596	28,880	48,060	35,274	47,399	49,493	47,289
Canada	15,653	15,102	23,589	19,621	23,259	33,069	25,243
France	89,397	114,749	112,765	98,986	109,789	115,411	118,607
Germany	206,130	237,215	234,680	230,270	256,726	255,844	246,364
Great Britain	214,287	252,595	223,436	229,719	218,586	216,381	210,980
Holland	5,732	5,961	6,504	7,165	7,496	6,944	10,472
Italy	33,290	40,296	34,612	31,085	40,013	36,376	35,935
Japan	15,983	10,582	12,676	18,188	20,833	24,030	20,393
Russia	27,668	49,349	42,328	53,792	47,289	50,265	64,815
Switzerland	5,842	6,514	5,842	6,504	5,512	7,055	6,393
Other European countries	3,417	4,416	4,409	4,740	3,858	4,850	6,944
Other countries	22,377	27,227	26,235	33,289	34,392	33,069	33,069
United States	367,903	324,176	367,504	397,763	353,828	394,159	414,281
Total	1,078,005	1,157,469	1,182,212	1,209,055	1,218,914	1,279,746	1,290,499

PRICES AND VALUE.

PRICES.

Lead began the year at New York with a price of 4.175 cents a pound and remained at 4.20 cents through the first part of February. The price declined to 3.8 cents by the 1st of April, rose to a little more than 3.9 cents by the 1st of May, and remained at that figure for four months. A sharp decline commenced in September and carried the price down to 3.5 cents in October, after which a rapid recovery brought the price up to 3.925 cents, but it dropped immediately to 3.8 cents, at which the year closed. The average New York price for the year was 3.9 cents a pound, compared with 4.4 cents in 1913 and 4.5 cents in 1912. These are the figures used in calculating the value of the production of lead in the United States for those years. The average price of lead at New York each year since 1825 is given in the tables on pages 801 and 802.

The London price of lead started at £18 5s. a long ton (3.94 cents a pound) and rose sharply until the latter part of January, when the maximum for the year was reached, at £20 7s. 6d. a long ton (4.41 cents a pound), three-tenths of a cent above the New York price. The London price consistently remained above the New York price until the end of July, after which, owing to the closing of the exchanges, there were no official quotations on lead until late in the year. The average price of lead for the first seven months of the year at London was £19 2s. 1d. a long ton (4.13 cents a pound), compared with 3.96 cents a pound at New York for the same period.

In the following table are shown the highest and the lowest prices of lead at New York in each month during the last 14 years. All figures for prices are in cents per pound. For years prior to 1907 the figures are based upon quotations published in the Iron Age. From 1907 to 1910, inclusive, the figures are taken from the Engineering and Mining Journal. Since 1910 the quotations of the Steel and Metal Digest have been used.

Highest and lowest prices of lead at New York City, monthly, 1901–1914, in cents per pound.

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.00	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.10	4.05	4.10	4.05	4.65	4.10	4.65	4.35
1904	4.50	4.45	4.50	4.40	4.60	4.50	4.60	4.50
1905	4.60	4.45	4.50	4.45	4.50	4.45	4.55	4.50
1906	5.60	5.60	5.60	5.35	5.35	5.35	5.50	5.35
1907	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1908	3.80	3.55	3.75	3.70	4.00	3.65	4.10	3.90
1909	4.22½	4.12½	4.15	3.92½	4.10	3.92½	4.25	4.10
1910	4.70	4.70	4.70	4.52½	4.60	4.35	4.40	4.35
1911	4.52½	4.50	4.50	4.50	4.50	4.45	4.50	4.47½
1912	4.50	4.25	4.30	4.05	4.25	4.05	4.30	4.17½
1913	4.37½	4.35	4.40	4.35	4.40	4.35	4.50	4.35
1914	4.20	4.10	4.20	4.00	4.00	3.80	3.95	3.80

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.35	4.30	4.35	4.10	4.10	4.05	4.10	4.05
1904	4.50	4.25	4.35	4.20	4.30	4.10	4.20	4.10
1905	4.55	4.50	4.55	4.50	4.60	4.50	4.85	4.60
1906	5.75	5.50	5.75	5.75	5.75	5.75	5.75	5.75
1907	6.00	6.00	6.00	5.75	5.75	5.25	5.25	5.25
1908	4.37½	4.05	4.52½	4.32½	4.52½	4.40	4.62½	4.47½
1909	4.35	4.20	4.35	4.35	4.35	4.30	4.42½	4.27½
1910	4.37½	4.25	4.40	4.30	4.45	4.35	4.40	4.40
1911	4.47½	4.45	4.50	4.45	4.60	4.50	4.60	4.55
1912	4.20	4.15	4.50	4.20	4.75	4.50	4.85	4.47½
1913	4.50	4.35	4.40	4.35	4.55	4.40	4.85	4.50
1914	3.95	3.90	3.90	3.90	3.90	3.90	3.90	3.90

Highest and lowest prices of lead at New York City, monthly, 1901–1914, in cents per pound—Continued.

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.00
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.40	4.10	4.40	4.35	4.40	4.10	4.25	4.10
1904	4.25	4.20	4.30	4.20	4.50	4.20	4.65	4.60
1905	4.90	4.85	5.30	4.85	5.40	5.15	5.90	5.25
1906	5.75	5.75	5.75	5.75	5.75	5.75	6.00	5.75
1907	5.25	4.75	4.75	4.75	4.75	4.00	4.10	3.35
1908	4.60	4.52½	4.47½	4.20	4.40	4.25	4.30	4.12½
1909	4.40	4.32½	4.37½	4.32½	4.40	4.32½	4.70	4.37½
1910	4.40	4.40	4.40	4.40	4.50	4.40	4.50	4.50
1911	4.55	4.50	4.50	4.25	4.50	4.25	4.47½	4.47½
1912	5.12½	4.80	5.15	5.00	5.00	4.50	4.50	4.32½
1913	4.80	4.65	4.70	4.35	4.40	4.25	4.25	4.00
1914	3.90	3.70	3.70	3.50	3.95	3.50	3.85	3.80

PRICE CURVES.

The fluctuations in the price of lead at New York and London are graphically shown in figure 8, which gives curves of the weekly average price of lead in those markets for the years 1913 and 1914.

VALUE.

The output of refined lead produced in the United States from domestic ores in 1914 was 512,794 short tons, valued at $39,997,932, based on the average New York price of refined lead, as compared with 411,878 tons, valued at $36,245,264, based on the average New York price in 1913, a gain of 100,916 tons, equal to nearly 25 per cent, in quantity and of $3,752,668, equal to a little more than 10 per cent, in value. The production in 1912 was 392,517 tons, valued at $35,326,530, and in 1911 it was 391,955 tons, valued at $35,279,550, all values being based on the average New York price.

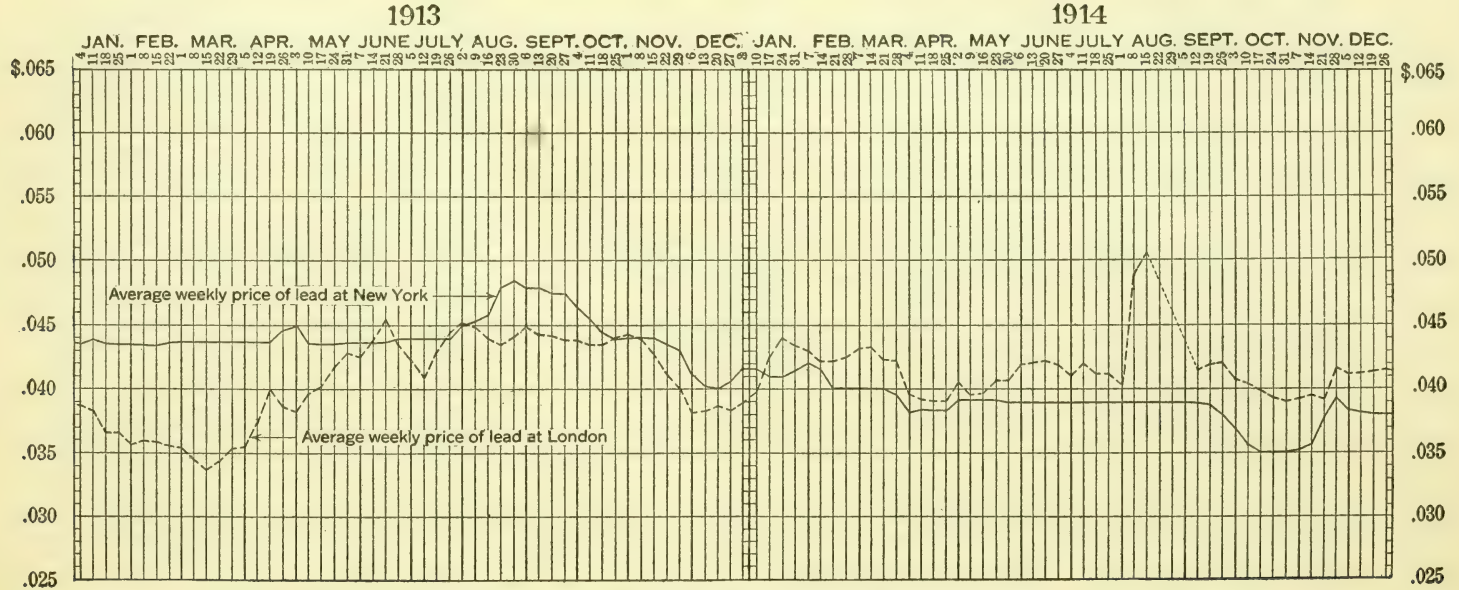

FIGURE 8.—Average weekly price of lead at New York and London, 1913-14.

CANADIAN LEAD BOUNTY.

The bounty paid by the Dominion of Canada to lead producers amounts to 75 cents per 100 pounds lead content of Canadian ore delivered to Canadian smelters when the London price of lead does not exceed £14 10s. per long ton (3.15 cents per pound). With increase in the price of lead the bounty decreases at the same ratio, ceasing altogether when lead is above £18 per long ton (3.91 cents per pound). The result of the bounty is to maintain to the producers a steady value for lead, under the present arrangement, of £18 per long ton.

Upon the termination of the first period of operation of the bounty on June 30, 1908, it was renewed for a second period of five years, with the maximum and minimum London price limits each raised £2 per long ton, giving the figures cited above. It was again renewed for five years in 1913.

The following figures, showing the amounts paid during several periods to March 31, 1915, are taken from the reports of the Canada department of mines:

Statement of bounties paid on lead during the fiscal years 1899 to 1914.

Year ending June 30—	Bounty paid.	Year ending March 31—	Bounty paid.
1899	$76,665	1907 (9 months)	$1,995
1900	43,335	1908	51,001
1901	30,000	1909	307,433
1902		1910	340,542
1903	4,380	1911	248,534
1904	195,627	1912	179,288
1905	330,645	1913	68,065
1906	90,196	1914	8,179
		1915	3,217
		Total	1,979,102

In 1906 and 1907 the average price of lead at London was 3.77 and 4.15 cents per pound, respectively, and as a result very little bounty was paid for the year ending March 31, 1907, although as may be seen from the table below there was an average production of lead in those years. Similarly from 1912 to 1914, the average London price was near or above the upper bounty limit and very little bounty was paid.

The lead production of Canada is chiefly from the mines of British Columbia. Prior to the enactment of the bounty this lead was largely smelted and refined in the United States, but since that time, or more particularly since the bounty was increased in 1908, most of the lead ores have been smelted and refined in Canada, as shown by the table below. The exports to the United States include some refined lead and probably some old or scrap lead. The lead smelter with electrolytic refinery at Trail, British Columbia, was built in 1904, and its capacity has been increased until for many years it has treated practically the whole output of lead ore in Canada.

Production of lead in Canada and exports of lead to the United States, 1899–1914, in short tons.

Year.	Total production.	Exports to United States.	Production of refined lead.	Year.	Total production.	Exports to United States.	Production of refined lead.
1899	10,831	8,936	.....	1907	23,869	6,636	13,304
1900	31,585	21,070	.....	1908	21,598	646	18,295
1901	25,950	26,065	.....	1909	22,929	2,067	20,942
1902	11,478	9,732	.....	1910	16,494	103	16,494
1903	9,070	9,600	.....	1911	11,892	135	11,892
1904	18,766	8,952	3,760	1912	17,882	160	17,858
1905	28,432	8,181	7,902	1913	18,831	169	18,207
1906	27,304	9,257	10,236	1914	18,169	192	18,222

SUMMARY.

The following tabular statement gives the general items regarding domestic and world production and consumption of lead. The figures for domestic items are those compiled by this Survey, and the figures for the world items are based upon statistics compiled by the Metallgesellschaft.

Summary of lead statistics, 1909–1914, in short tons.

	1909	1910	1911	1912	1913	1914
Total production of refined lead in the United States	446,901	470,272	486,979	480,894	462,460	542,122
Production of desilverized lead in the United States	329,751	328,954	331,032	339,646	330,593	383,903
Production of soft lead in the United States (including desilverized soft)	149,690	169,270	191,614	171,037	161,300	201,725
Production of antimonial lead in the United States	12,896	14,069	14,078	13,552	16,665	16,667
Production of lead from domestic ores	352,839	375,402	391,995	392,517	411,878	512,794
Production of secondary lead in the United States	41,687	55,422	54,284	67,168	72,834	61,062
Consumption of lead in the United States (disregarding stocks)	367,504	397,763	353,828	394,159	414,281	451,371
World production (approximate)	1,164,903	1,210,504	1,227,648	1,282,513	1,270,458	.....
World consumption (approximate)	1,182,212	1,209,055	1,218,914	1,279,746	1,290,499	.....
United States (domestic) percentage of world production	30.3	31.0	32.0	30.6	32.4	.....
United States percentage of world consumption	31.1	32.9	29.0	30.8	32.1	.....
World rank of United States in production of lead	First.	First.	First.	First.	First.	.....
World rank of United States in consumption of lead	First.	First.	First.	First.	First.	.....

BIBLIOGRAPHY.

A list of the more important publications on lead and zinc published by the United States Geological Survey is given in the chapter on zinc in Mineral Resources for 1914.

GOLD AND SILVER.

(GENERAL REPORT.)

By H. D. McCaskey.[1]

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To all those engaged in the mining and metallurgical industries, to merchants, bankers, and transportation officials of the United States and Alaska, to the Bureau of the Mint, the Post Office Department, and the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and to other officials, public and private, who have cooperated with the United States Geological Survey in furnishing information on the production of gold and silver, acknowledgment is most gratefully made. To the authors of the Survey mines reports on the production of gold, silver, copper, lead, and zinc in the Eastern, Central, and Western States and in Alaska, Messrs. A. H. Brooks, B. S. Butler, J. P. Dunlop, C. N. Gerry, V. C. Heikes, Charles W. Henderson, and Charles G. Yale, the writer is especially indebted.

PRODUCTION OF GOLD AND SILVER IN 1914.

The recovered output of gold and silver in the United States from domestic ores and gravels in 1914 is shown below.

Approximate distribution, by producing States and Territories, of the production of gold and silver in the United States for the calendar year 1914, in fine ounces.[a]

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	495	$12,300	300	$200
Alaska	800,471	16,547,200	865,900	478,800
Arizona	221,020	4,568,900	4,439,500	2,455,000
California	1,028,061	21,251,900	2,020,800	1,117,500
Colorado	962,779	19,902,400	8,804,400	4,868,800
Georgia	813	16,800	100	100
Idaho	57,431	1,187,200	12,573,800	6,953,300
Illinois	.....	.....	1,900	1,200
Maryland	10	200	100	100
Michigan	.....	.....	415,500	229,800
Missouri	.....	.....	60,000	33,200
Montana	200,446	4,143,600	12,536,700	6,932,800
Nevada	558,064	11,536,200	15,877,200	8,780,100
New Mexico	58,974	1,219,100	1,771,300	979,500
North Carolina	6,303	130,300	1,500	800
Oklahoma	.....	.....	6,200	3,400
Oregon	76,887	1,589,400	147,400	81,500
Philippine Islands	53,179	1,099,300	10,300	5,700
Porto Rico	135	2,800	.....	.....
South Carolina	155	3,200	.....	.....
South Dakota	354,782	7,334,000	179,800	99,400
Tennessee	309	6,400	102,800	56,800
Texas	426	8,800	574,700	317,800
Utah	163,362	3,377,000	11,722,000	6,482,300
Virginia	15	300	1,500	800
Washington	28,435	587,800	341,300	188,700
Wyoming	324	6,700	100	100
Total	4,572,976	94,531,800	72,455,100	40,067,700

[a] Gold value, $20.67+per fine ounce. Average commercial price of silver in 1914, 55.3 cents per fine ounce.

[1] Valuable aid has been rendered by J P. Dunlop in the preparation of the tables of this report.

The figures in this table result from cooperation of the Bureau of the Mint and the United States Geological Survey and are agreed upon after conference and adjustment between the two bureaus. They are, therefore, final for both.

The totals of this table are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by information collected by the United States Geological Survey directly from the producing mines and tabulated for the mines reports later discussed. The data giving the total production, and in part the distribution, are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ores and matte exported for reduction. The last item is of small relative importance.

Gains and losses in the production of gold and silver in the several States and Territories, as compared with the output of 1913, are shown in the following table:

Increase (+) or decrease (−) in production of gold and silver in the United States in 1914, by States and Territories, in fine ounces.

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	+ 152	+ $3,100	+ 200	+ $100
Alaska	+ 65,107	+ 1,345,900	+ 499,200	+ 257,300
Arizona	+ 22,614	+ 467,500	+ 527,500	+ 92,200
California	+ 48,887	+ 1,010,600	+ 599,300	+ 258,900
Colorado	+ 86,722	+ 1,792,700	− 185,300	− 561,000
Georgia	+ 168	+ 3,500		
Idaho	− 2,762	− 57,100	+ 3,096,700	+ 1,229,100
Illinois			− 400	− 200
Maryland	− 22	− 500	+ 100	+ 100
Michigan			+ 81,800	+ 28,200
Missouri			+ 21,100	+ 9,700
Montana	+ 39,799	+ 822,700	− 3,600	− 641,500
Nevada	− 21,344	− 441,200	+ 219,800	− 677,000
New Mexico	+ 15,825	+ 327,100	+ 104,400	+ 27,300
North Carolina	+ 729	+ 15,100	− 200	− 200
Oklahoma			+ 5,400	+ 2,900
Oregon	+ 5,392	+ 111,500	− 24,800	− 22,500
Philippine Islands	+ 18,975	+ 392,300	+ 4,000	+ 1,900
Porto Rico	+ 85	+ 1,700		
South Carolina	− 43	− 900		
South Dakota	+ 5,794	+ 119,800	+ 7,200	− 4,800
Tennessee	− 62	− 1,300	− 6,200	− 9,000
Texas	+ 415	+ 8,600	+ 144,900	+ 58,200
Utah	− 9,349	− 193,300	+ 439,700	− 332,200
Virginia	+ 4	+ 100	+ 1,300	+ 700
Washington	− 3,371	− 69,700	+ 122,600	+ 56,600
Wyoming	− 523	− 10,800	− 1,100	− 600
Increase (+) or decrease (−)	+ 273,192	+ 5,647,400	+ 5,653,600	− 280,400

In addition to the production of gold and silver from domestic sources in 1914, the domestic smelters and refineries produced as refined bullion from foreign ore, matte, and unrefined bullion 875,250 fine ounces of gold and 39,789,129 fine ounces of silver. Of the foreign gold, 199,652 ounces is credited to Mexico, 532,572 ounces to

Canada (including British Columbia, the Yukon, and the Klondike), 61,123 ounces to Central America, 45,161 ounces to South America, 320 ounces to Cuba, and 36,420 ounces to all other foreign sources. Of the foreign silver, 19,643,774 fine ounces is credited to Mexico, 7,084,354 ounces to Canada, 2,458,094 ounces to Central America, 5,432,676 ounces to South America, 51,542 ounces to Cuba, and 5,118,689 ounces to all other foreign sources.

PRICES OF SILVER.

The average monthly prices of fine silver in New York in 1914 were as follows:

Price of silver per fine ounce in 1914, by months.

January	$0.58217	August	(1)
February	.58234	September	$0.53159
March	.58723	October	.50555
April	.59095	November	.49630
May	.58600	December	.50145
June	.56879		
July	.55201	Yearly average	.55312

The average annual price of silver per fine ounce from 1865 to 1914, inclusive, has been:

Annual price of silver per fine ounce in New York, 1865–1914.

1865	$1.337	1890	$1.05
1866	1.339	1891	.99
1867	1.33	1892	.87
1868	1.326	1893	.78
1869	1.325	1894	.63
1870	1.328	1895	.65
1871	1.325	1896	.68
1872	1.322	1897	.60
1873	1.297	1898	.59
1874	1.278	1899	.60
1875	1.24	1900	.62
1876	1.16	1901	.60
1877	1.20	1902	.53
1878	1.15	1903	.54
1879	1.12	1904	.58
1880	1.15	1905	.61
1881	1.13	1906	.68
1882	1.14	1907	.66
1883	1.11	1908	.53
1884	1.11	1909	.52
1885	1.07	1910	.54
1886	.99	1911	.53
1887	.98	1912	.615
1888	.94	1913	.604
1889	.94	1914	.553

[1] No quotation.

WORLD'S PRODUCTION OF GOLD.

The production of gold in the world from 1860 to 1914, inclusive, is shown in the following table:

Production of gold in the world, 1860–1914.

[The annual production from 1860 to 1872 is obtained from 5-year periods compiled by Dr. Adolph Soetbeer. From 1872 to 1912, inclusive, the estimates are those of the Bureau of the Mint. The figures for 1913 and 1914 are in part final and in part estimates of the Survey from best available information, and are subject to revision.]

Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.
1860	$134,083,000	1875	$97,500,000	1890	$118,848,700	1905	$380,288,700
1861	122,989,000	1876	103,700,000	1891	130,650,000	1906	402,503,000
1862	122,989,000	1877	113,947,200	1892	146,651,500	1907	412,966,600
1863	122,989,000	1878	119,092,800	1893	157,494,800	1908	442,476,900
1864	122,989,000	1879	108,778,800	1894	181,175,600	1909	454,059,100
1865	122,989,000	1880	106,436,800	1895	198,763,600	1910	455,239,100
1866	129,614,000	1881	103,023,100	1896	202,251,600	1911	461,939,700
1867	129,614,000	1882	101,996,600	1897	236,083,700	1912	466,136,100
1868	129,614,000	1883	95,392,000	1898	286,879,700	1913	454,942,211
1869	129,614,000	1884	101,729,600	1899	306,724,100	1914	453,000,000
1870	129,614,000	1885	108,435,600	1900	254,576,300		
1871	115,577,000	1886	106,163,900	1901	260,992,900	Total	11,257,320,811
1872	115,577,000	1887	105,774,900	1902	296,737,600		
1873	96,200,000	1888	110,196,900	1903	327,702,700		
1874	90,750,000	1889	123,489,200	1904	347,377,200		

In the following table is shown the output of gold, by countries, for the 12 years ending 1914:

World's production of gold, 1903–1914, by countries.

Country.	1903	1904	1905	1906	1907	1908
North America:						
United States	$73,591,700	$80,464,700	$88,180,700	$94,373,800	$90,435,700	$94,560,000
Canada	18,834,500	16,462,500	14,610,400	12,023,900	8,382,800	9,482,100
Mexico	10,677,500	12,605,300	16,107,100	18,534,700	18,681,100	22,371,200
Africa	67,998,100	85,913,900	113,254,700	135,358,000	151,984,100	166,520,500
Australasia	89,210,100	87,767,300	85,926,500	82,391,400	75,677,700	73,327,300
Europe:						
Russia and Finland	24,634,200	24,803,200	22,292,200	19,496,500	26,684,300	28,052,200
Austria-Hungary	2,245,100	2,117,300	2,457,400	2,615,400	2,484,900	2,469,300
Germany	70,500	64,700	66,700	80,400	66,600	64,800
Norway	2,700					
Sweden	33,900	40,200	36,700	13,300	18,700	14,500
Italy	26,700	44,000	44,000	41,200	39,600	46,500
Spain and Portugal	6,700					
Turkey	20,700	29,000	6,000	6,000	4,500	2,200
France				502,400	835,400	1,147,400
Great Britain	94,000	359,800	112,700	29,200	29,200	16,000
Servia				59,800	59,800	59,800
South America:						
Argentina	30,000	9,200	5,500	5,500	103,000	161,300
Bolivia	2,900	21,900	18,800	754,600	1,267,400	346,300
Chile	636,900	636,900	948,500			
Colombia	2,724,400	1,974,400	2,584,000	2,190,800	3,255,600	3,427,300
Ecuador	274,400	132,900	188,500	294,200	267,100	350,300
Brazil	2,280,400	2,043,500	2,044,600	2,403,000	2,020,700	2,196,600
Venezuela	300,000	300,000	171,400	25,300	22,400	24,500
Guiana—						
British	1,611,300	1,608,800	1,690,700	1,607,700	1,304,400	1,408,100
Dutch	375,900	441,600	632,500	689,200	640,000	663,000
French	2,101,500	1,806,400	1,859,700	1,858,900	2,360,800	2,135,500
Peru	592,600	1,329,200	516,100	829,000	514,500	514,500
Uruguay	51,500	25,000	50,000	31,700	51,900	91,600
Central America	1,875,300	1,252,500	1,513,400	1,910,700	2,107,800	3,018,800
Asia:						
Japan	2,891,200	2,948,200	3,072,400	2,748,900	2,773,000	3,321,600
China	7,324,700	4,500,000	4,500,000	4,500,000	4,500,000	8,647,300
Indo-China					31,800	65,600
Chosen (Korea)	3,000,000	3,000,000	2,593,000	2,283,000	2,170,800	3,047,500
Siam		51,800	48,600	53,200	166,200	327,600
India, British	11,428,900	11,722,900	11,950,200	12,087,700	10,383,600	10,598,500
East Indies, British	1,344,800	1,485,300	1,391,000	1,448,700	1,561,300	1,400,900
East Indies, Dutch	1,409,600	1,414,500	1,414,500	1,254,900	2,079,900	2,596,300
Total	327,702,700	347,377,200	380,288,700	402,503,000	412,966,600	442,476,900

World's production of gold, 1903–1914, by countries—Continued.

Country.	1909	1910	1911	1912	1913	1914
North America:						
United States	$99,673,400	$96,269,100	$96,890,000	$93,451,500	[a] $88,884,400	[a] $94,531,800
Canada	9,382,200	10,205,800	9,762,100	12,648,800	[a] 16,216,131	[a] 15,925,044
Mexico	23,842,900	24,910,600	24,880,100	24,500,000	[b] 18,250,000	[c] 18,000,000
Cuba	.....	.....	20,000	.....	[c] 24,600	.....
Africa	170,988,600	175,189,900	191,538,400	211,850,600	[d] 205,875,000	[c] 201,000,000
Australasia	71,007,900	65,470,600	60,184,200	54,509,400	[a] 53,038,090	[e] 49,386,180
Europe:						
Russia and Finland	32,381,300	35,579,600	32,151,600	22,199,000	[f] 24,578,575	[c] 26,750,000
Austria-Hungary	1,942,000	2,172,600	2,185,100	2,043,200	[d] 2,180,414	[c] 1,500,000
Germany	69,200	62,900	78,100	78,100	[c] 60,000	.....
Norway	.....	1,400	.....	.....	.....	.....
Sweden	10,100	2,000	2,000	20,300	[d] 36,630	.....
Italy	24,200	29,600	44,800	11,000	[d] 30,572	.....
Spain and Portugal	2,900	2,800	2,400	2,300	[f] 2,500	.....
Turkey	500	500	500	500	[f] 500	.....
France	1,400,600	1,707,100	1,812,100	1,812,100	[f] 1,946,600	[c] 1,000,000
Great Britain	21,500	39,600	39,600	27,800	[a] 17,860	.....
Servia	150,300	.....	251,100	251,100	[c] 250,000	100,000
South America:						
Argentina	189,900	173,100	289,000	107,300	[c] 100,000	.....
Bolivia and Chile	492,400	463,600	362,500	175,000	[c] 800,000	[c] 500,000
Colombia	3,179,900	3,370,000	3,167,800	2,971,700	[c] 3,000,000	[c] 3,000,000
Ecuador	274,400	249,200	276,800	406,500	[g] 289,133	.....
Brazil	2,252,900	1,954,700	3,834,500	3,570,600	[d] 3,009,786	[c] 3,000,000
Venezuela	280,600	340,500	364,800	623,500	[d] 444,800	.....
Guiana—						
British	1,192,700	1,192,700	892,000	879,800	[d] 1,353,368	[c] 1,250,000
Dutch	621,000	792,600	523,400	407,300	[d] 470,433	[c] 500,000
French	2,143,800	2,229,100	2,229,100	3,050,600	[h] 3,050,600	[c] 3,000,000
Peru	514,500	455,900	492,300	492,200	[h] 492,200	[c] 500,000
Uruguay	91,600	91,600	70,600	111,000	[h] 111,000	.....
Central America	2,630,100	4,657,400	3,360,400	3,030,400	[c] 3,000,000	[c] 3,500,000
Asia:						
Japan	3,616,900	3,903,600	4,118,600	4,467,000	[a] 4,470,723	[i] 4,476,500
China	9,352,100	3,658,100	3,314,600	3,658,900	[h] 3,658,900	[c] 3,800,000
Indo-China	65,600	55,000	74,700	74,700	[c] 70,000	.....
Chosen (Korea)	1,993,600	4,399,100	2,889,400	2,852,600	[d] 3,281,333	[c] 3,750,000
Siam	327,600	56,500	56,500	56,500	[h] 56,500	.....
India, British	10,358,600	10,718,400	11,054,100	11,055,700	[a h] 11,152,463	[e] 11,388,870
East Indies, British	1,436,900	1,446,800	1,339,400	1,352,000	[h] 1,352,000	4,750,000
East Indies, Dutch	2,146,400	3,387,100	3,387,100	3,387,100	[h] 3,387,100	
Total	454,059,100	455,239,100	461,939,700	466,136,100	454,942,211	[d k] 453,000,000

[a] Official.
[b] Min. World, Feb. 6, 1915.
[c] Estimated.
[d] Director Mint Ann. Rept., 1914. (Africa includes Transvaal, Rhodesia, West Africa, Congo, and Madagascar.)
[e] Min. Mag., April, 1915.
[f] Min. Mag., August, 1914.
[g] Min. Jour., Dec. 5, 1914.
[h] Mineral Industry, 1914.
[i] Min. and Sci. Press, May 8, 1915.
[k] Includes estimates for countries not specified.

The figures above given for the years 1903 to 1912, inclusive, are from the reports of the Director of the Mint. It has been impracticable for the Bureau of the Mint to compile a table of world's figures for 1913 and 1914 and compilations have therefore been made by the Survey, from available sources and necessarily including estimates where complete data are lacking.

The figures show a steady increase of total world's output, from $327, 702, 700 in 1903 to $466,136,100 in 1912, followed by a decrease to $454,942,211 in 1913, and a probable further decrease to about $453,000,000 in 1914. The indications, however, do not point to a continued decrease in 1915, for increased activity at the great Rand mines, in the Transvaal, South Africa, promises to offset decrease probable elsewhere due to shortage of labor because of the European war or for other reasons.

A survey of the statistics for the last 12 years shows the rapidly increasing actual output and proportion of the total yield of Africa,

attributable to the great mines of the Rand; the fluctuations of the production of the United States and of Russia; the steady decline in Australasia; and the fairly constant output from British India and many other countries.

PRODUCTION OF GOLD AND SILVER SINCE 1792.

According to tables published by the Director of the Mint, the total production of gold and silver in the United States from 1792 to 1914, inclusive, is as follows:

Production of gold and silver in the United States, 1792–1914, by periods, in fine ounces.

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and since by the Director of the Mint.]

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1792–1847	1,187,170	$24,537,000	309,500	$404,500
1848–1872	58,279,778	1,204,750,000	118,568,200	157,749,900
1873–1914	116,392,479	2,406,044,200	2,039,543,500	1,591,430,900
Total	175,859,427	3,635,331,200	2,158,421,200	1,749,585,300

The table following shows the quantity and value of these metals produced in the United States since 1880:

Production of gold and silver in the United States from 1880 to 1914, inclusive, in fine ounces.

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1880	1,741,500	$36,000,000	30,318,700	$34,717,000
1881	1,678,612	34,700,000	33,257,800	37,657,500
1882	1,572,187	32,500,000	36,196,900	41,105,900
1883	1,451,250	30,000,000	35,732,800	39,618,400
1884	1,489,950	30,800,000	37,743,800	41,921,300
1885	1,538,373	31,801,000	39,909,400	42,503,500
1886	1,686,788	34,869,000	39,694,000	39,482,400
1887	1,603,049	33,136,000	41,721,600	40,887,200
1888	1,604,478	33,167,500	45,792,700	43,045,100
1889	1,594,775	32,967,000	50,094,500	46,838,400
1890	1,588,877	32,845,000	54,516,300	57,242,100
1891	1,604,840	33,175,000	58,330,000	57,630,000
1892	1,597,098	33,015,000	63,500,000	55,662,500
1893	1,739,323	35,955,000	60,000,000	46,800,000
1894	1,910,813	39,500,000	49,500,000	31,422,100
1895	2,254,760	46,610,000	55,727,000	36,445,500
1896	2,568,132	53,088,000	58,834,800	39,654,600
1897	2,774,935	57,363,000	53,860,000	32,316,000
1898	3,118,398	64,463,000	54,438,000	32,118,400
1899	3,437,210	71,053,400	54,764,500	32,858,700
1900	3,829,897	79,171,000	57,647,000	35,741,100
1901	3,805,500	78,666,700	55,214,000	33,128,400
1902	3,870,000	80,000,000	55,500,000	29,415,000
1903	3,560,000	73,591,700	54,300,000	29,322,000
1904	3,892,480	80,464,700	57,682,800	33,456,000
1905	4,265,742	88,180,700	56,101,600	34,222,000
1906	4,565,333	94,373,800	56,517,900	38,256,400
1907	4,374,827	90,435,700	56,514,700	37,299,700
1908	4,574,340	94,560,000	52,440,800	28,050,600
1909	4,821,701	99,673,400	54,721,500	28,455,200
1910	4,657,018	96,269,100	57,137,900	30,854,500
1911	4,687,053	96,890,000	60,399,400	32,615,700
1912	4,520,717	93,451,500	63,766,800	39,197,500
1913	4,299,783	88,884,400	66,801,500	40,348,100
1914	4,572,976	94,531,800	72,455,100	40,067,700
Total	102,852,715	2,126,152,400	1,831,133,800	1,340,356,500

IMPORTS AND EXPORTS.

The following table gives a summary of imports and exports of gold and silver during 1914:

Imports and exports of gold and silver during the calendar year 1914.

[Figures furnished by the Bureau of Foreign and Domestic Commerce.]

Metal.	Imports.	Exports.	Excess of—	
			Imports.	Exports.
GOLD.				
Contained in domestic ore and base bullion		$285,038		$285,038
Contained in foreign ore and base bullion	$11,076,682		$11,076,682	
Domestic bullion refined		52,508,148		52,508,148
Foreign bullion refined	16,607,890	411	16,607,479	
United States coin	19,341,469	167,900,857		148,559,388
Foreign coin	10,361,700	1,921,702	8,439,998	
Total	57,387,741	222,616,156	36,124,159	201,352,574
Excess of exports				165,228,415
SILVER.				
Contained in domestic ore and base bullion		76,084		76,084
Contained in foreign ore and base bullion	7,017,207		7,017,207	
Domestic bullion refined		47,235,904		47,235,904
Foreign bullion refined	17,194 964	1,953,476	15,241,488	
United States coin	1,554,542	531,674	1,022,868	
Foreign coin	192,474	1,805,922		1,613,448
Total	25,959,187	51,603,060	23,281,563	48,925,436
Excess of exports				25,643,873

MINES REPORT.

METHOD OF COLLECTING STATISTICS.

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1914 as agreed upon by the Bureau of the Mint and the United States Geological Survey. With the comparatively unimportant exceptions of domestic gold and silver contained in ores and mattes exported for reduction during the year, these figures record the actual production of gold and silver bullion from domestic ores in marketable form as metals, either refined or unrefined.

Owing to the difficulty of tracing this total gold and silver production back to its origin by States, counties, and mining districts, however, the Geological Survey attacks this problem of distribution by systematic investigation of the mine production of ores containing gold and silver during the calendar year and of the output of the placer mines. In this way the state of the mining industry is studied in detail, and classification of output by methods of production and by kinds of ore, as well as by mining districts, is obtained. The resulting figures form the basis of the mines report.

Of the two plans outlined for ascertaining the gold and silver production of the United States it may be said that the one is a measure of the mining industry and the other a measure of the metallurgical industry; and one reports the production and recoverable content of mine output and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results, nor should they be expected to do so.

The figures of the reports of the Mint and of the mines reports for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error due to the complex nature of the ores and of the methods of treatment.

For the last 10 years the final figures for mint and mine returns have been as follows:

Production of gold and silver, 1905–1914, according to mint and to mine returns.

Years.	Mint.		Mine.	
	Gold.	Silver.	Gold.	Silver.
		Ounces.		*Ounces.*
1905	$88,180,700	56,101,600	$88,159,881	56,272,496
1906	94,373,800	56,517,900	97,219,645	57,362,455
1907	90,435,700	56,514,700	87,471,136	52,500,104
1908	94,560,000	52,440,800	91,914,891	50,878,140
1909	99,673,000	54,721,500	99,438,144	57,315,677
1910	96,209,100	57,137,900	94,933,778	57,598,509
1911	96,890,000	60,399,400	97,054,791	61,108,791
1912	93,451,500	63,766,800	92,880,467	66,041,506
1913	88,884,400	66,801,500	89,987,888	71,200,237
1914	94,531,800	72,455,100	92,703,757	69,633,769
Total	937,250,000	596,857,200	931,764,378	599,911,684

These figures show according to Mint reports, an excess of gold for the 10 years of $5,485,622, or a difference of not quite 0.6 per cent, but a deficit of silver production of 3,054,484 fine ounces, or a difference of a little more than 0.5 per cent. The figures for Alaska placers are not considered to be as closely approximate as these figures, hence the differences for the United States proper are probably even lower. It is thought these comparatively small differences are accounted for by the explanations given in the detailed discussions of previous reports of this series. For figures of any one year an excess of mining over smelting and refining, whether of gold and silver or of base metal ore or of both, is indicated by larger figures in the mine reports for gold or silver or for both, and opposite relations or excess of smelting and refining over mining by drawing upon stocks is suggested by the reverse figures.

UNITS OF MEASUREMENT.

In measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price per fine ounce of precious metals (gold excepted, which is fixed by law at $20.67+per fine ounce) is based upon the averages of daily market prices. The annual average commercial prices current for silver from 1865 to 1914, inclusive, are given elsewhere in this report.

PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The following table gives the quantity and value of recoverable gold and silver output by States reported from the producing mines in 1914 to the United States Geological Survey. The increase or decrease of production shows results from comparison with the corresponding Survey mine figures for 1913.

Mine production of gold and silver in the United States in 1914 as reported to the United States Geological Survey, by States and Territories, in fine ounces and value.

State or Territory.	Gold.		Silver.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Gold. (value).	Silver (quantity).
Alabama	579.05	$11,970	199	$110	+ $876	+ 82
Alaska	762,596.03	15,764,259	394,805	218,327	+ 137,446	+ 32,242
Arizona	202,166.62	4,179,155	4,377,994	2,421,031	+ 155,244	+ 429,903
California	999,112.87	20,653,496	1,471,859	813,938	+ 246,538	+ 93,460
Colorado	961,845.20	19,883.105	8,796,065	4,864,224	+1,736,189	− 529,190
Georgia	787.06	16,270	67	37	+ 1,162	− 8
Idaho	55,743.24	1,152,315	12,479,516	6,901,172	− 192,244	+ 2,490,323
Illinois			2,112	1,168		− 1,429
Maryland and Pennsylvania	10.88	225	44	24	+ 225	+ 44
Michigan			413,500	228,665		+ 118,327
Missouri			61,168	33,826		+ 25,548
Montana	199,203.94	4,117,911	12,016,460	6,645,102	+ 624,479	− 1,802,741
Nevada	555,402.47	11,481,188	15,455,491	8,546,887	− 313,942	− 638,592
New Mexico	56,680.79	1,171,696	1,777,445	982,927	+ 289,770	+ 146,172
North Carolina	6,343.94	131,141	1,524	843	+ 4,693	− 288
Oklahoma			6,187	3,421		+ 4,887
Oregon	76,986.92	1,591,461	142,552	78,831	− 36,249	− 36,484
Philippines	66,347.00	1,371,514	10,500	5,807	+ 503,152	− 2,500
Porto Rico	135.46	2,800	20	11	+ 1,684	+ 11
South Carolina	356.04	7,360	33	18	+ 2,479	− 7
South Dakota	354,758.45	7,333,508	176,642	97,683	+ 14,214	+ 3,940
Tennessee	299.63	6,194	97,402	53,864	− 1,401	− 10,703
Texas	11.32	234	530,817	293,542	− 106	+ 103,264
Utah	157,961.16	3,265,347	11,154,916	6,168,669	− 299,882	− 1,929,919
Vermont					− 3	− 105
Virginia	20.76	429	1,458	806	− 175	+ 498
Washington	26,953.24	557,173	264,861	146,468	− 139,102	− 66,378
Wisconsin			16	9		+ 16
Wyoming	242.17	5,006	116	64	− 19,178	− 841
Total	4,484,544.24	92,703,757	69,633,769	38,507,474	+2,715,869	− 1,566,468
Increase (+) or decrease (−) in value					+2,715,869	−$4,497,469

An increase in the production of gold of $2,715,869 and a decrease in the output of silver of 1,566,468 fine ounces are shown by the mines reports for the United States for 1914 as compared with 1913. These changes are in the opposite direction from those of the two preceding years.

The principal gold-producing States ranked as follows in 1914: California, Colorado, Alaska, Nevada, South Dakota, Arizona, Montana, Utah, Oregon, Philippines, Idaho, and New Mexico. No other State has produced over $1,000,000 in the last five years. The most notable increases in gold output in 1914 were $1,736,189 in Colorado, $624,479 in Montana, and $503,152 in the Philippines. The largest decreases were $313,942 in Nevada, $299,882 in Utah, $192,244 in Idaho, and $139,102 in Washington.

The principal silver-producing States ranked as follows in 1914: Nevada, Idaho, Montana, Utah, Colorado, Arizona, New Mexico, and California. No other State has produced 1,000,000 ounces of silver in any one of the last four years. The largest increase in silver output in 1914 was 2,490,323 ounces in Idaho, and the largest decreases were 1,929,919 ounces in Utah and 1,802,741 ounces in Montana.

MINE PRODUCTION OF GOLD AND SILVER, BY STATES.

ALASKA.

It is estimated by A. H. Brooks that the total output of gold from Alaska, from earliest mining in 1880 to the end of 1914 has been $244,156,799, of which $175,712,992 has come from placers. The total output of silver has been 3,851,416 fine ounces, of which 1,494,221 ounces was derived from the refining of placer gold and 1,462,348 ounces was recovered from Alaskan copper ores.[1]

Gold.—The mine production of gold in Alaska in 1914 was $15,764,259 against $15,626,813 in 1913. The yield from siliceous ores was $4,863,028 and that from copper ores was $171,231. The placers contributed $10,730,000, against $10,680,000 in 1913. Forty-two dredges produced $2,350,000 of the placer gold in 1914.

From the Pacific coast belt, including southeastern Alaska and Prince William Sound, the production of gold was $4,538,157 in 1914, against $4,529,529 in 1913. From the Copper River and Cook Inlet region it was $597,681—a considerable increase over the output of $378,643 in 1913. From the Yukon and Kuskokwim basins the production decreased from $8,183,641 in 1913 to $7,895,421 in 1914. From Seward Peninsula and northwestern Alaska, however, the output increased slightly, from $2,535,000 in 1913 to $2,733,000 in 1914.

Lode mining in the Juneau gold belt of southeastern Alaska is of increasing interest owing to the development of the large low-grade ore bodies of the Alaska-Juneau and Alaska-Gastineau mines, the great mills of which, with the well-known mills of the Treadwell group on Douglas Island, are expected to bring the production of this region to one of foremost importance. Dredging for gold, especially on the Seward Peninsula, has also become of first-rate magnitude and will offset to some extent decreased placer production by more primitive methods, as at Fairbanks and elsewhere.

About 32 per cent of the total output of gold in Alaska came from lode mines in 1914, against 31.6 per cent in 1913, 29 per cent in 1912, and 24 per cent in 1911, indicating a gradual transition from placer to lode mining. Nine of the 28 gold lode mines operated in 1914 were in southeastern Alaska, and these produced the bulk of the $4,232,538 in gold from this region.

The 730 placers operated during the whole or part of 1914 yielded about 8,500,000 cubic yards of auriferous gravel, with an average recovery of $1.26 per yard, of which the dredges handled about 4,450,000. The gold lode mines produced 1,738,127 tons of ore, with an average gold and silver recovery of $2.80 per ton, and six copper mines produced 153,605 tons of ore, with an average copper content of 6.98 per cent and a gold and silver recovery value of $2.14 per ton.

Silver.—The mine production of silver in Alaska in 1914 was 394,805 fine ounces, against 362,563 ounces in 1913. The copper mines produced 283,355 ounces in 1914, against 273,179 ounces in 1913; the placers produced 83,196 ounces and the gold ores 28,254 ounces.

[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 127, 1915.

ARIZONA.

Gold.—The mine production of gold in Arizona in 1914 was $4,179,155, against $4,023,911 in 1913. This was the largest production of gold from Arizona mines to date. Placers contributed $30,140 in gold, mainly from Yavapai, Pima, and Yuma counties. The deep mines produced $4,149,015, principally from dry or siliceous ores in Mohave, Maricopa, and Yavapai counties, and from copper ore in Cochise County. Mohave County again led in output of gold with a total of $1,891,214, followed by Cochise with $1,014,675, and by Yavapai and Maricopa with over a half million dollars each. The Tom Reed and Gold Road mines, in the San Francisco district of Mohave County, and the Vulture, in Maricopa County, were, as formerly, the largest producers. The copper mines, mainly of the Warren (Bisbee) district of Cochise County, also were large contributors. Of the gold recovered by gold milling, amounting to $2,416,143 in 1914, much the greater part was produced by cyanidation. The remainder of the output was obtained from crude ores and concentrates smelted, chiefly from the former.

Silver.—The mine production of silver in Arizona in 1914 was 4,377,994 fine ounces, against 3,948,091 ounces in 1913. Of this production 2,604,371 ounces came from copper ores, of which Cochise County produced 1,636,610 ounces, mainly from the Warren (Bisbee) district, and Yavapai County contributed 479,899 ounces, chiefly from the Verde district. Dry and siliceous gold and silver ores produced 1,133,976 ounces, of which Cochise County produced 774,135 ounces and Yavapai County 283,275 ounces. Lead ores yielded 493,226 ounces, of which 339,593 ounces came from Cochise County and 109,459 ounces from Santa Cruz County. Altogether Cochise County produced 2,753,953 ounces of silver in 1914, and again led all other counties by a wide margin. Of the total output of silver in Arizona for the year 3,280,667 ounces came from crude ores shipped to smelters, 423,982 ounces from concentrates shipped, and 617,049 ounces from mill bullion, chiefly by cyanidation.

CALIFORNIA.

Gold.—The mine production of gold in California in 1914 was $20,653,496, against $20,406,958 in 1913. The increased output was about equivalent to the greater placer yield, for the production from siliceous and from lead ores decreased in about the same proportion as that from copper and from silver-lead ores increased.

The deep mines produced $11,572,647 in gold, of which the gold-quartz ores supplied $11,198,841 and the copper ores $343,776. The placers produced in all $9,080,849, of which $7,783,394 was contributed by the dredges, $702,884 by hydraulic mines, $329,948 by drift mines, and $264,623 by sluicing or surface mines.

The dredges produced nearly 38 per cent of the total output of gold in California, and all the other placers about 6 per cent. The total dredge production from 1898 to the end of 1914 has been $71,307,766. Of the three great dredging fields in 1914, Yuba County produced $2,755,734, an increase of $335,279; Sacramento County produced $2,161,653, a decrease of $336,950; and Butte

County (including Oroville and the outside districts) decreased in output $485,411. Altogether the dredge production of California fell off in 1914 to the amount of $306,900, due mainly to exhaustion of certain fields.

The counties leading in output of gold in 1914 were Nevada, with $3,301,948; Amador, with $3,082,002; Yuba, with $2,800,713; Sacramento, with $2,164,491; Butte, with $1,697,120; Calaveras, with $1,336,875; and Shasta, with $1,101,202. Of these Yuba, Sacramento, and Butte are mainly dredging fields; Amador and Calaveras are on the Mother Lode; Shasta produces from both siliceous and copper ores; and Nevada produces mainly from gold-quartz milling ores of the Grass Valley district.

The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—whose output is also mainly gold milling ores, produced $3,235,116 in gold from mill bullion and $1,809,682 from concentrates in 1914, or $5,044,798 in all, against a total output of $4,678,053 in 1913.

Silver.—Mine production of silver in California was 1,471,859 fine ounces in 1914, against 1,378,399 ounces in 1913. Nearly half of the output, or 703,042 ounces, came from copper ores, chiefly from Shasta County, but also from Calaveras County, and 448,054 ounces came from silver-lead ores, mainly from Inyo County. Smelting ore produced altogether 1,267,752 ounces. The remainder came from milling ores, principally by amalgamation and cyanidation.

COLORADO.

Gold.—The mine production of gold in Colorado in 1914 was valued at $19,883,105, against $18,146,916 in 1913—an increase of $1,736,189.

The Cripple Creek district produced $11,996,116, or 60 per cent of the State output, an increase of $1,091,113 over the output of 1913. The Roosevelt Tunnel continued to lower the water level in the mines drained by it, and an important extension of the tunnel is now being driven to drain the country including the Vindicator and Golden Cycle mines, an additional distance of over 10,000 feet, along the line of tunnel. Flow of water has considerably increased and a much greater increase is expected when the extension leaves the granite and enters the breccia. In this last-named ground the services of the tunnel as a means for prospecting at depth are also expected to increase in value. The completed work will drain the ground below various shaft collars at the following depths: El Paso, 1,289 feet; Vindicator, 2,100 feet; Golden Cycle, 1,955 feet; Blue Bird, 2,300 feet; Portland, 2,145 feet; Elkton, 1,645 feet; Findley, 2,295 feet; Last Dollar, 2,175 feet; Cresson, 1,925 feet; American Eagles, 2,645 feet.

The San Juan region, in Dolores, La Plata, Ouray, San Juan, and San Miguel counties, produced $3,969,857, a decrease following a decrease in 1913. There was, however, an increased output of $252,616 in Ouray County. Besides this county and Cripple Creek (Teller County) increased output was shown in Summit, Park, Lake (Leadville), Gunnison, Clear Creek, Chaffee, and Boulder counties, but there was notable decrease in Gilpin, Mineral, Custer, and Hinsdale counties.

Of the total material treated, dry and siliceous ores constituted nearly 86 per cent (against 79 per cent in 1913), and yielded $18,476,892, or nearly 93 per cent of the total output of gold. A little more than 3 per cent of the output came from placers and about the same quantity from lead ores. The placer production was $642,360 in 1914, an increase of $233,820. Summit County with 8 placers and 4 dredges again produced about 95 per cent of the total placer output.

Silver.—The mine production of silver in Colorado in 1914 was 8,796,065 fine ounces, a decrease of 529,190 ounces from the output of 1913. Lake County—principally Leadville—produced 3,810,830 ounces (or 43 per cent of the total) in 1914, against 3,400,318 ounces in 1913, and increased output also came from Boulder, Chaffee, Custer, Eagle, Ouray, Saguache, San Miguel, and Teller counties; but there was notable decrease in Clear Creek, Gunnison, Hinsdale, La Plata, Mineral, Park, Pitkin, San Juan, and Summit counties.

Of the total State production, dry or siliceous ores furnished 6,584,493 fine ounces, mainly from Lake and San Miguel counties, and lead ores supplied 1,532,943 ounces, chiefly from Lake, Pitkin, San Juan, and Boulder counties. Lead-zinc ores, also mainly from Lake County, supplied 414,298 ounces.

IDAHO.

Gold.—The mine production of gold from Idaho in 1914 was $1,152,315, against $1,344,559 in 1913. The placer production was $700,454, of which $568,989 was from dredging operations. Boise County supplied $601,227 in gold from all sources, and Lemhi County $305,991. In these counties most of the dredging was done, and the output from this source has been increasing. Since dredging began in Idaho in 1897, gold valued at $2,907,819 has been produced by this method. The production of gold from deep mines was only $451,861 in 1914 and has been falling off since the closing of the larger producers in Owyhee County.

Silver.—The mine production of silver in Idaho in 1914 was 12,479,516 fine ounces, a new record yield, against the previous record output of 9,989,193 ounces in 1913. This increase of nearly 25 per cent was almost entirely from the silver-bearing lead and lead-zinc ores of the Coeur d'Alene region, of Shoshone County, which produced nearly 98 per cent of the silver output of Idaho. The Hunter district, at Mullan, produced 1,057,347 ounces; the Lelande district, at Burke and Mace, 5,565,372 ounces; and the Yreka district, 4,887,926 ounces. Of the total State output, concentrates furnished 8,845,309 ounces and crude ore 3,612,369 ounces, all of which was shipped to smelters. The concentrating mills of Idaho are of first rank in importance, but smelting facilities are lacking, and both crude ore and concentrates are shipped outside for further treatment.

MARYLAND AND PENNSYLVANIA.

Gold and silver.—There was a nominal output only of gold and silver from the refining of very small quantities of gold bullion and of copper from Maryland mines in 1914. No silver was reported recovered during the year from the copper produced annually as a by-product from the Cornwall iron mines at Lebanon, Pa.

MICHIGAN.

Silver.—The copper mines of Michigan produced 413,500 ounces of silver in 1914, against 295,173 ounces in 1913. The output of silver is mainly from the electrolytic refining of the copper. The average recovery of silver per ton of "rock" treated (both conglomerate and amygdaloid) was 0.04 ounce in both years. Of the total output in 1914 Houghton County produced 382,625 ounces and Keweenaw County the small remainder.

MISSOURI, OKLAHOMA, ILLINOIS, KENTUCKY, AND WISCONSIN.

Silver.—The lead and zinc mines of the Central States produce no gold and but little silver. This last is a by-product, mainly from the refining of lead from concentrates produced at the lead mines of southeastern Missouri. The recovery averages about 1 ounce of silver per ton of concentrates saved, and lead from only about 25 per cent of these concentrates was desilverized. A small output of silver was also made from copper ores. The total mine production of silver in Missouri in 1914 was 61,168 ounces, against 35,620 ounces in 1913.

The only mine whose output was mainly silver in the Central States in 1914 was one near Byars, Okla., which produced ore yielding 6,187 ounces in that year.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field carry silver, and from the lead concentrates produced in Illinois in 1914 a recovery of 2,112 ounces was recorded, against 3,541 ounces in 1913.

A few ounces of silver were also obtained from copper ore shipped from Lafayette County, Wis., in 1914.

MONTANA.

Gold.—The mine production of gold in Montana in 1914 was $4,117,911, against $3,493,432 in 1913. The placer yield was $942,217, of which $835,615 was obtained by five large dredges. During the preceding decade the State production of gold had declined, but in 1914 the placer output increased $141,215 and the output from deep or lode mines increased $483,264. Cyanidation and amalgamation mills produced $819,444 in gold; concentrates from milling ores produced $553,400, and crude ores smelted, $1,802,850. Madison County led again in production, largely from dredging operations in Alder Gulch district, and was followed by Deer Lodge County, whose output was chiefly from siliceous ores smelted, and by Silver Bow, whose yield was mainly from the smelting of concentrates from the Butte copper mines.

Silver.—The mine production of silver in Montana in 1914 was 12,016,460 ounces, against 13,819,201 ounces in 1913. The copper ores yielded 8,015,694 ounces, of which Silver Bow County (Butte) supplied 7,949,948 ounces. The lead-zinc ores produced 2,302,332 ounces, of which Silver Bow also produced practically all. The dry or siliceous silver ore, gold ore, and gold-silver ore produced 1,249,555 ounces, of which Granite County supplied 647,694 ounces. The output from lead-zinc ores at Butte considerably increased, but that from copper ores and siliceous ores decreased. In county yield Silver Bow

continued predominant with a total production of 10,511,032 ounces of silver in 1914, against 12,211,725 ounces in 1913. The decrease was due to curtailment at the Butte copper mines, but for which the production for both county and State would have been considerably greater than in 1913.

NEVADA.

Gold.—The mine production of gold in Nevada in 1914 was $11,481,188, against $11,795,130 in 1913—a continuation of the annual decline that has been notable since the highest production of $18,878,864 was reached in 1910. The production of Esmeralda County was $5,226,367 (of which the Goldfield district yielded $4,705,210 in 1914), against $5,721,077 in 1913 and $7,014,559 in 1912. Nye County produced $3,377,262, of which Tonopah yielded $2,648,833. Humboldt, Storey, Mineral, White Pine, Churchill, and Eureka counties also each produced over $300,000 in gold. Although the rich ores of Goldfield are not now so plentiful as formerly, recent development in lower levels indicates that the life of the camp may be considerably prolonged by lower-grade ores.

Silver.—For three years prior to 1914 the mine production of silver from Nevada had been steadily increasing, but in 1914 there was a slight decrease, chiefly because of the lower price for the metal in the last half of the year. The total output was 15,455,491 ounces, against 16,090,083 ounces in 1913; and yet Nevada held first place in production of silver in 1914. Nye County (almost wholly from the Tonopah district) was again in the lead, with 11,424,769 ounces, followed by Churchill with 1,545,926 ounces (mainly from Fairview and Wonder districts). The Comstock Lode, or Storey County, produced only 278,599 ounces in 1914. Of the total output the dry or siliceous ores, mostly silver ores, yielded 14,724,094 ounces, including the bulk of the output from Nye and Churchill counties, practically all of whose ores were treated by milling and cyanidation.

NEW MEXICO.

Gold.—The mine production of gold in New Mexico in 1914 was $1,171,696, against $881,926 in 1913 and $784,446 in 1912, indicating a continued increase. Socorro County produced $631,367, or nearly 54 per cent of the State total, almost entirely from the siliceous milling ores at Mogollon. There was increased output from Colfax, Dona Ana, Grant, Lincoln, Sandoval, Sierra, and Socorro counties. The dry or siliceous ores yielded $901,922 in 1914, and the copper ores $234,676, chiefly from Central, Lordsburg, and Pinos Altos districts in Grant County. The placer output was $29,152.

Silver.—The mine production of silver in New Mexico in 1914 was 1,777,445 ounces, against 1,631,273 ounces in 1913. Socorro County produced 1,424,763 ounces, or 80 per cent of the total, chiefly from the siliceous milling ores of Mogollon, the remainder from mixed ores of the Magdalena district. Grant County supplied 304,679 ounces, mainly from the Lordsburg district. Dry and siliceous ores, chiefly from Socorro and Grant counties, yielded 1,459,814 ounces, or 82 per cent of the total, and copper ores, largely from Grant, Socorro, and Santa Fe counties, supplied 292,266 ounces, or 16 per cent. The Chino copper ores of Grant County are remarkably low in gold and

silver, but during 1914 somewhat increased recovery in precious metals was reported, mainly in gold. The gold and silver tenor, however, continues exceptionally low.

OREGON.

Gold.—The mine production of gold in Oregon in 1914 was $1,591,461, against $1,627,710 in 1913, a slight decrease from 1913, but a considerably higher output than for any other recent year. The output is almost wholly from siliceous milling ores and from placers, the former showing a material decrease and the latter a considerable increase. Baker County alone produced $1,313,967, leading in output from both ores and gravels by a large margin. Josephine County produced $111,428, mainly from placers. Altogether the Oregon placers yielded $548,317 in 1914, an increase of $97,689. There was but one dredge in operation, but it made a notable yield, and another boat has been built. The deep mines, producing almost wholly gold milling siliceous ores, yielded $1,043,144 in 1914, a decline of $133,938.

Silver.—The mine production of silver in Oregon in 1914 was 142,552 ounces, a decrease of 36,484 ounces, most of the output being from siliceous milling ores, principally from Grant and Baker counties.

SOUTH DAKOTA.

The total value of the production of gold in South Dakota from 1876 to the end of 1914 is given by Charles W. Henderson, of the United States Geological Survey, as $185,287,640. The total output of silver for the same period was 5,832,669 fine ounces, valued at $4,213,674.[1]

Gold.—The mine production of gold in South Dakota in 1914 was $7,333,508, against $7,319,294 in 1913. The output is almost wholly from siliceous milling ores and the bulk of this is low grade and is treated both by amalgamation and cyanidation. The Homestake mines and mills were operated continuously and produced $6,160,161 in bullion from 1,587,774 tons of ore treated. The company reports a continued large reserve of ore and a saving of 94 per cent of the values in treatment. The Golden Reward, Reliance, and Trojan mills were also operated regularly and the new Mogul mill began work. There was a small output of shipping ore and a small placer output from the State.

Silver.—The output of silver, derived mainly from refining the gold mill bullion produced, was 176,642 ounces, or about the same as in 1913.

SOUTHERN APPALACHIAN STATES.

The total production of gold from 1799 to the end of 1914 in the southern Appalachian States is given by J. P. Dunlop, of the United States Geological Survey, as $50,689,568.[2] The data are compiled from early reports of the Director of the Mint and recent reports of the Geological Survey. The figures credit Alabama, from 1830 to 1914, inclusive, with $749,384; Georgia, for the same period, with

[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 240, 1915.
[2] U. S. Geol. Survey Mineral Resources, pt. 1, p. 142, 1915.

$17,752,627; Maryland, from 1867 to 1914, with $71,339; North Carolina, from 1799 to 1914, with $23,416,357; South Carolina, from 1829 to 1914, with $5,176,237; Tennessee, from 1831 to 1914, with $230,217; and Virginia, from 1828 to 1914, with $3,293,407. The output of all of these States, except North Carolina, has been relatively small in recent years, but the region is classic ground and the placers and free-milling quartz lodes produced the first gold for domestic coinage, which caused the establishment of a United States mint at Dahlonega, Ga., and a United States assay office at Charlotte, N. C. The region also furnished the first trained gold miners and stamp-mill operators to develop the gold fields of Colorado and California.

Gold.—The combined mine production of gold in Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia in 1914 was $173,364, against $165,733 in 1913. North Carolina again ranked first, with $131,141, followed by Georgia with $16,270, Alabama with $11,970, and South Carolina with $7,360. The output is almost wholly from gold-quartz ores and from placers. The output from Tennessee was $6,194, entirely from copper ores of the Ducktown district.

Silver.—The output of silver from the southern Appalachian States was 100,727 ounces in 1914, against 111,205 ounces in 1913. Tennessee supplied the bulk of this as usual (97,402 ounces in 1914) from the Ducktown copper mines.

TEXAS.

Gold.—The total output of gold from Texas mines from 1885 to the end of 1914 is given by Charles W. Henderson as $46,618.[1] The yield has been merely nominal and a by-product, being only $234 in 1914 and $340 in 1913.

Silver.—The total production of silver in Texas from 1885 to 1914, inclusive, has been 11,742,409 fine ounces, valued at $7,924,494, according to Henderson. The mine production of silver in 1914 was 530,817 ounces, against 427,553 ounces in 1913. The bulk of the Texas production of silver has been from the oxidized milling ores of the Presidio mine, Shafter district, Presidio County, whose ores were first treated by amalgamation and more recently by cyanidation. Operations continued throughout 1914.

UTAH.

Gold.—The total output of gold in Utah from 1864 to 1914, inclusive, is given by V. C. Heikes, of the United States Geological Survey, as $82,580,121.[2] There has been a continued decrease in recent years due mainly to declining output and final exhaustion of the Mercur mines of Tooele County.

The mine production of gold in Utah in 1914 was valued at $3,265,347, against $3,565,229 in 1913. Salt Lake County again had the largest output, $2,159,500 in 1914, against $1,777,214 in 1913. The Bingham district alone, with its enormous output of copper and other ores, produced $2,151,520 in gold in 1914. The Tintic district,

[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 236, 1915.
[2] Idem, p. 718.

partly in Juab and partly in Utah counties, produced $953,790 (a large decrease) principally from dry and siliceous, copper, and lead ores. The greater part of the Utah production of gold is now from copper ores concentrated and smelted principally from Salt Lake and Juab counties, but a considerable production in these counties comes from lead ores. Dry and siliceous ores from Juab County also yield considerable gold in smelting. The total output in gold mills by amalgamation and cyanidation has become very small, and the placer output is now insignificant.

Silver.—The total output of silver in Utah from 1864 to 1914, inclusive, has been 326,975,152 fine ounces, according to V. C. Heikes.

The mine production of silver in Utah in 1914 was 11,154,916 fine ounces, against 13,084,835 ounces in 1913. Juab County again ranked first in output with 4,444,996 ounces, mainly from lead ores, but also largely from dry or siliceous ores and from copper ores. Salt Lake County produced 2,629,153 ounces from lead and copper ores in nearly equal quantity, and Summit County produced 2,418,564 ounces, mainly from lead ores. Altogether the lead ores of Utah yielded 7,350,213 ounces of silver, the copper ores 1,726,230 ounces, and the dry or siliceous ores 1,317,364 ounces. A large output came from concentrates smelted, but the bulk of the production was from crude ores shipped to smelters. The Tintic district produced 4,666,944 ounces in 1914, mainly from lead ores; the West Mountain, or Bingham district, 2,383,051 ounces, chiefly from copper and lead ores; and the Park City mining region, 2,955,008 ounces, chiefly from lead ores.

WASHINGTON.

The total output of gold in Washington from earliest mining to the end of 1914 is given by C. N. Gerry, of the United States Geological Survey, as valued at $25,987,294, and the total production of silver as 6,180,162 ounces.[1]

Gold.—The mine production of gold in Washington in 1914 was valued at $557,173, a decrease of $139,102 from the value in 1913. The greater portion of the production was from crude siliceous ore shipped to smelters, but there was also a considerable output from this class of ore milled and cyanided. Ferry County alone produced $513,276 in 1914 against $645,009 in 1913, the bulk of it, as usual from the Republic district.

Silver.—The mine production of silver in Washington in 1914 was 264,861 fine ounces against 331,239 ounces in 1913, derived mainly from crude dry or siliceous ores from Ferry County, but also from copper ores and concentrates from Stevens County.

WYOMING.

The total production of gold in Wyoming, from 1867 to the end of 1914, is given by Charles W. Henderson as $1,196,184 and the output of silver for the same period as 58,796 fine ounces.[2]

Gold.—The mine production of gold in Wyoming in 1914 was $5,006, against $24,184 in 1913. This output came from siliceous ores and placers, chiefly the former, and was mainly from the Atlantic City (South Pass) district.

[1] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 641, 1915.
[2] Idem, p. 249.

Silver.—The mine production of silver in Wyoming in 1914 was 116 fine ounces, against 957 ounces in 1913.

PHILIPPINE ISLANDS.

The output of gold in the Philippines from 1907 to 1914, inclusive, has been $3,516,261, according to Victor E. Lednicky, of the Division of Mines of the Philippine Bureau of Science.[1] These islands have produced gold more or less regularly for three centuries, and the earliest Spanish explorers visited and described the fields. Undoubtedly, the rich placer fields of many years ago made a considerable output, and since the American occupation it has been hoped that western men and methods might materially revive the declining industry, but it is only after long effort that the many difficulties have been sufficiently overcome for production to begin to be notable. Gold mining and metallurgy, including the latest American practice in prospecting and dredging gravels and milling and cyaniding the gold-quartz ores, may now be said to be upon a firm foundation, and an extension of production both from lode mines and from placers may be looked for.[2]

Gold.—The mine production of gold in the Philippines in 1914 was $1,174,633, against $868,362 in 1913 and $570,212 in 1912. About $610,000 was produced by the quartz mines of the Arroroy district on the island of Masbate, where the Colorado, Syndicate, and Keystone mines, equipped with modern all-sliming cyanidation mills, are the principal producers. The placers of the Paracale-Mambulao district in the Camarines Province of southeastern Luzon produced about $515,000 from seven dredges, some of them representing the most advanced stages of construction. About $30,000 came from Benguet Province, and about $20,000 from other regions in the highlands of northern Luzon. Production from all these districts may be expected to increase in 1915.

Silver.—The mine production of silver in the Philippines in 1914 was 10,300 ounces, and was recovered entirely from gold bullion refined.

NUMBER OF PRODUCING MINES.

The following table indicates the number of mines producing gold and silver in 1914 divided into placers and deep, or lode, mines. The placers are those in which the gold and the silver in natural alloy with the gold and, in a few instances, with platinum, are recovered from gravels and sands, whether by hand washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or by dredging. The deep mines are those producing gold and silver (from ores as distinguished from gravels), mainly from underground workings, including those whose ores are valuable chiefly for copper, lead, or zinc, but which contribute precious metals as by-products. In addition to producing mines here enumerated, many properties were being prospected and developed without making any output in 1914, and many other mining claims were being held by assessment work only.

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[1] Mineral resources of the Philippine Islands for the year 1914, pp. 9–10, Manila, 1915.

[2] Requests for information on the mineral resources of the Philippines should be addressed to the Division of Mines, Bureau of Science, Manila, P. I. This organization has accomplished much in field studies and in publication of the essential facts of Philippine geology. The detailed information is mainly published in the Philippine Journal of Science, whose agent in the United States is the Macmillan Co., 64–66 Fifth Avenue, New York City.

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and individually small, and because the production is frequently by transitory miners not regularly working placer ground. The unit, so far as possible is, however, as for deep mines, not the operator, but the mining claim or group of claims.

Number of producing mines in 1914, by States and Territories.[a]

State or Territory.	Number of mines.		
	Placer.	Deep.	Total.
Alabama	1	2	3
Alaska	730	38	768
Arizona	57	338	395
California	340	318	658
Colorado	35	831	866
Georgia	26	11	37
Idaho	208	176	384
Illinois[b]	.....	2	2
Maryland and Pennsylvania	.....	3	3
Michigan[b]	.....	10	10
Missouri and Oklahoma[b]	.....	5	5
Montana	147	358	505
Nevada	111	620	731
New Mexico	24	115	139
North Carolina	12	9	21
Oregon	77	28	105
South Carolina	6	1	7
South Dakota	10	20	30
Tennessee[c]	.....	2	2
Texas	.....	4	4
Utah	7	204	211
Vermont and New Hampshire	.....	1	1
Virginia	.....	3	3
Washington	17	50	67
Wisconsin[b]	.....	1	1
Wyoming	7	8	15
Total	1,815	3,158	4,973

[a] Philippines and Porto Rico not included.
[b] Number of mines contributing to silver production.
[c] Number of mines contributing to gold and silver production.

The table shows the number and distribution of mines producing gold and silver in the United States and Alaska. With the exception of (1) some of the Michigan copper mines, (2) all zinc mines in the Eastern and Central States and a few in the Far West, and (3) all lead mines of the Central States (except a few in Illinois and southeastern Missouri), practically all mines producing copper, lead, and zinc in the United States and Alaska produce gold and silver also. The table, therefore, with these exceptions, is a table of mines producing these five metals. It also includes certain mines producing oxidized manganese iron fluxing ores of Colorado, Utah, and elsewhere, whose ores contain small quantities of precious metals, especially silver, and are smelted as flux.

Comparisons with the corresponding figures for 1913 show a net total decrease of 303 producing mines, following decreases also in 1912 and in 1911. This decrease may be due in part to consolidations, in part to closer estimates for placer operators, and in part to actual falling off in number of active producing properties caused, perhaps, by failure of prospecting to develop sufficient producing mines to take the place of mines no longer on the producing list.

For the last nine years the number of producing properties has been as follows:

Number of mines producing gold and silver, 1906–1914.

Year.	Placer.	Deep.	Total.
1906	2,316	2,114	4,430
1907	2,586	2,604	5,190
1908	2,599	2,864	5,463
1909	2,187	3,183	5,370
1910	2,026	3,299	5,325
1911	2,146	3,553	5,699
1912	2,044	3,567	5,611
1913	1,774	3,502	5,276
1914	1,815	3,158	4,973
Average	2,166	3,094	5,260

The figures show that fewer placer mines and more deep mines were reported as producers in 1914 than the respective averages for the period.

In total number of operating mines Colorado again ranked first with 866, followed in order by Alaska with 768, Nevada with 731, California with 658, and Montana with 505. In number of placers Alaska led with 730, followed by California with 340, and Idaho with 208; and in deep mines Colorado led with 831, followed by Nevada with 620, Montana with 358, Arizona with 338, and California with 318.

ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUE.

The best index of deep mining is, of course, the quantity, metallic content, and value of ore mined, rather than the number of mines or of operators. In the next following table is given the production of ore by classes of ore and by States and Territories from mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals. The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ores are both very small. The copper ores include those containing over $2\frac{1}{2}$ per cent of copper, or less than this percentage in the cases of the great disseminated copper deposits of the West and of the Lake Superior ores; in general, the lead ores are those containing $4\frac{1}{2}$ per cent or more of lead, and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious metal content; but ores of lower grades in lead and especially in zinc are treated profitably in some places, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of those enumerated.

Ore production in short tons and average extraction value of gold and silver per ton in 1914, by States and Territories.[a]

State or Territory.	Dry or siliceous ores.		Copper ores.		Lead ores.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama and Georgia	6,829	$2.46				
Alaska	1,738,127	2.80	153,605	$2.14		
Arizona	428,805	8.46	7,508,020	.33	26,687	$11.92
California	2,050,797	5.53	397,868	1.84	16,820	16.99
Colorado	2,157.762	10.25	12,196	13.38	193,087	7.66
Idaho	43,513	8.85	93,040	1.66	1,421,893	3.42
Maryland and Virginia [b]	11	20.00	1,495	.84		
Michigan [b]			2,000,000	.20		
Montana	342,085	9.37	4,346,034	1.14	29,636	8.62
Nevada	1,594,486	11.39	2,882,121	.39	16,088	13.13
New Mexico	169,046	10.11	2,005,024	.20	2,491	6.20
North Carolina [c]	19,441	7.17	10	14.90		
Oklahoma	190	18.00				
Oregon	124,274	8.99			57	32.98
South Carolina	7,531	.92				
South Dakota	2,019,255	3.68			7	35.57
Tennessee [c]			653,621	.09		
Texas	40,375	7.09	231	16.34		
Utah	149,902	7.38	7,578.220	.39	600,481	7.91
Washington	73,892	8.66	21,752	2.51	303	10.41
Wisconsin [b]			37	.27		
Wyoming	345	9.22	78	.56		
Total, 1914	10,966,666	6.95	27,653,352	.49	2,307,550	5.29
Percentage of tonnage	25.46		64.26		5.36	
Total, 1913	10,656,738	7.15	30,850,693	.54	2,563,904	4.98
Percentage of tonnage	23.29		67.43		5.60	

State or Territory.	Zinc ores.		Copper-lead and copper-lead-zinc ores.		Lead-zinc ores.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Alabama and Georgia							6,829
Alaska							1,891,732
Arizona	18,079	$2.86	4,892	$4.08	23,444	$2.53	8,009,927
California							2,465,485
Colorado	145,656	.004	1,192	43.11	167,633	1.72	2,677,526
Idaho	8,473	.34			668,430	2.91	2,235,349
Maryland and Virginia [d]	14,004						15,510
Michigan [d]							2,000,000
Montana	9,066	3.05	168	18.17	401,967	3.40	5,128,956
Nevada	9,490	3.90	3,762	12.77	16,075	3.96	4,522,022
New Mexico	[b] 55,912		380	11.45			2,232,853
North Carolina [e]							19,451
Oklahoma							190
Oregon							124,331
South Carolina							7,531
South Dakota							2,019,262
Tennessee [e]	357,437						1,011,058
Texas	24				1,640	2.21	42,270
Utah	4,670		1,183	18.76	209,558	2.75	8,544,014
Washington							95,947
Wisconsin [d]							37
Wyoming							423
Total, 1914	622,811	.19	11,577	12.87	1,488,747	2.90	43,050,703
Percentage of tonnage	1.44		.02		3.46		
Total, 1913	231,547	.31	24,399	22.61	1,427,027	2.48	45,754,308
Percentage of tonnage	.51		.05		3.12		100.00

[a] Illinois, Missouri, the Philippines, and Porto Rico not included; crude-ore tonnage, containing precious metals not known.
[b] Includes only copper ore yielding precious metals.
[c] Lead and zinc ores yielded no precious metals.
[d] Includes only copper ore yielding precious metals.
[e] Lead and zinc ores yielded no precious metals.

The total quantity of ore sold or treated and from which gold and silver were produced decreased from 45,754,308 short tons in 1913 to 43,050,703 tons in 1914. The output continued, however, much greater than that of 1912 and of preceding years and will probably materially increase in 1915.

Utah, Arizona, and Montana continued to lead in quantity of ore owing to their vast output from copper mines, that from the first two States being largely from low-grade disseminated ores and that from Montana largely from the Butte vein deposits. Nevada ranked next in quantity of ore, with output mainly from the Ely copper ores but also largely from Tonopah, Goldfield, and other dry or siliceous ores. Colorado, California, Idaho, and New Mexico came next, with tonnage for the first two chiefly from dry and siliceous ores from many famous camps, for Idaho mainly from the lead and lead-zinc ores of the Coeur d'Alene, and for New Mexico chiefly from the copper ores of the disseminated type. South Dakota, Michigan, and Alaska ranked next, the first and third notable for the great outputs of siliceous ore from the Homestake and Juneau regions, and Michigan for the great output of copper ores.

The average gold and silver extraction values were high for the siliceous ores of Nevada, Colorado, New Mexico, and a few other States and low for the great ore bodies of California, South Dakota, and Alaska. They were also high for the copper ores of Colorado and low for the ores of most of the other important copper-producing States, notably so for Utah, Nevada, Arizona, and New Mexico. The lead ores of Utah also averaged more than double those of Idaho in precious metal value per ton.

Nearly 26 per cent of the output of ore considered as producing gold and silver was dry or siliceous ore, against 23 per cent in 1913; and 64 per cent was copper ore, against 67 per cent in 1913; only about 5 per cent was lead ore; and a little over 3 per cent was lead-zinc ore in either year. The average precious-metal extraction value per ton of siliceous ores decreased from $7.15 to $6.95 for the entire United States, and of copper ore from $0.54 to $0.49 per ton. The average gold and silver value of lead ores increased from $4.98 to $5.29 per ton, however, and of lead-zinc ores from $2.48 to $2.90 per ton.

DISTRIBUTION OF PRODUCTION OF GOLD IN 1914, BY SOURCES.

As shown by the following table, the great bulk of the domestic output of gold is from dry or siliceous ores—normally gold quartz and gold-silver quartzose ores—and from placers, nearly 92 per cent of the total production of gold coming from these sources alone. The total contribution of gold derived from the great copper, lead, and zinc mines of the country is therefore relatively small, notwithstanding their recent enormous development and tonnage. The changes in relative output from the various sources given in the table have been unimportant in the last four years. It is interesting to note, however, the gradual increase in placer production from 23.76 per cent in 1910 to 24.17 per cent in 1911, to 24.94 per cent in 1912 to 24.96 per cent in 1913, and to 25.30 per cent in 1914; also corresponding decreases in output from dry or siliceous ores from 68.91 per cent in 1910 to 68.52 per cent in 1911, to 67.29 per cent in 1912, and to 66.45 per cent in 1913. There was a slight increase in

1914, however, to 66.56 per cent. The changes are mainly due to increased dredging output on the one hand and to decrease in tenor of some of the great gold-quartz ore bodies worked on the other.

The following table shows the sources by classes of ore, by States, of the mine production of gold in 1914, and for comparison of totals by sources the corresponding figures for 1913 are given:

Source of mine production of gold in 1914 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placer.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama	24.19	554.86						579.05
Alaska	519,063.75	235,248.98	8,283.30					762,596.03
Arizona	1,458.02	145,255.71	50,842.80	2,188.48	1,570.45	108.75	742.41	202,166.62
California	439,286.07	541,815.62	16,630.16	1,381.02				999,112.87
Colorado	31,074.16	893,819.64	3,243.88	30,525.24	2.24	288.91	2,891.13	961,845.20
Georgia	534.20	252.86						787.06
Idaho	33,884.46	17,582.57	1,076.54	2,467.13	6.77		725.77	55,743.24
Maryland		10.64	.24					10.88
Montana	45,579.75	121,599.07	25,422.61	1,972.44	41.99	6.63	4,581.45	199,203.94
Nevada	18,250.05	484,796.50	49,476.59	2,541.09	291.70	46.54		555,402.47
New Mexico	1,410.22	43,630.49	11,352.45	268.86		18.77		56,680.79
North Carolina	324.45	6,012.91	6.58					6,343.94
Oregon	26,524.83	50,388.32		73.77				76,986.92
South Carolina	21.72	334.32						356.04
South Dakota	67.97	354,688.88		1.60				354,758.45
Tennessee			299.63					299.63
Texas							11.32	11.32
Utah	59.55	18,274.43	97,955.32	33,094.69		78.17	8,499.00	157,961.16
Virginia			20.76					20.76
Washington	278.45	26,453.86	220.93					26,953.24
Wyoming	89.06	153.11						242.17
Total, 1914	1,117,930.90	2,940,872.77	264,831.79	74,514.32	1,913.15	547.77	17,451.08	4,418,061.78
Value	$23,109,683	$60,793,236	$5,474,559	$1,540,348	$39,548	$11,323	$360,746	$91,329,443
Percentage of total	25.30	66.56	6.00	1.69	0.04	0.01	0.40	
Total, 1913	1,075,783.74	2,864,900.58	275,633.75	73,880.52	896.30	4,696.89	15,311.28	4,311,103.06
Value	$22,238,424	$59,222,751	$5,697,855	$1,527,246	$18,528	$97,094	$316,512	$89,118,410
Percentage of total	24.96	66.45	6.39	1.69	0.02	0.11	0.36	

[a] Philippines and Porto Rico not included.

PLACERS.

GENERAL.

The total value of the production of placer gold was $23,109,683 in 1914, against $22,238,424 in 1913. The placer production increased in Alaska, California, Colorado, Idaho, Montana, Nevada, and Oregon in 1914.

The placer production is chiefly from dredging, from drift mining (which is of decreasing importance in Alaska in frozen ground at no great depth, but of continued importance in California in ancient buried river channels, often at considerable depth), and from hydraulic and sluicing placers. In California, especially, hydraulic mining has been of much importance in the past and had become a special branch of the industry in itself, but restrictive laws relative to the débris and to disturbance of navigable streams have in recent years greatly confined mining activity of this kind. Finally, there is also a small annual output of gold from dry placers in the South-

west, and also a production of gold and platinum from ocean-beach mining in California and Oregon.

Some interesting notes on beach mining in California and Oregon, and on dry placers in California, by Charles G. Yale, and on dry placers in Arizona, Nevada, and New Mexico, by V. C. Heikes, were published in the Survey report on gold and silver for 1912, copies of which can still be had on application to the Director, United States Geological Survey, Washington, D. C.

A geologic investigation of the placer deposits of the United States is now being made by James M. Hill, of the United States Geological Survey, and cooperative work on the technology is being done by Charles Janin, of the United States Bureau of Mines. The investigation will require considerable field study as well as office work, and it is hoped that operators will assist in furnishing the necessary data requested, as well as the annual statistics for the Mineral Resources reports, in order that publication of the results may not be unduly delayed.

DREDGING.

The production of gold by dredging in the United States and Alaska from the commercial beginning of the industry in 1896 to the record output of 1914, inclusive, has amounted, according to best available data, to $94,833,468, and the value will probably have passed the $100,000,000 mark by the middle of 1915.

Profitable dredging for gold is first noted from Grasshopper Gulch in the Bannock district, Beaverhead County, Mont., where a Bucyrus double-elevator bucket dredge was operated as early as 1893–94. Before that time, and only too frequently since, dredging operations had been attempted in various regions only to fail because of insufficient knowledge of the ground or of the engineering and financial features of the work. Dredges of various types have been tried without permanent success—clam-shell, suction, single bucket, spoon or scoop, and pump—until finally has been evolved the modern bucket-elevator machine of amazing capacity and endurance, fitted, according to the special conditions involved, to overcome natural obstacles that have blocked earlier attempts, operated in many cases by electric power, and profitably treating material unprofitable under all other known or attempted methods of operation. From the Bannock district dredging extended to Alder Gulch, near Ruby, in Madison County, and operations have been continuous in Montana since, with a total yield from this source of more than $6,500,000. In Idaho, where the gravels of the Boise Basin have been worked by this method, dredging has produced nearly $3,000,000 and been continuous since 1897. In Colorado dredging has been practiced in the Breckenridge district, Summit County, since 1901, and has produced over $2,700,000 in gold. In New Mexico, from 1902 to 1905, inclusive, a dredge was operated on Cimarron River, near Elizabethtown, in Colfax County, and added materially at that time to the gold output of the State. The gravels became finally too poor to operate, according to report, and work came to an end. In Alaska dredging has been continuous and of increasing importance since 1903 and is now an important factor in the production of gold—over $10,000,000 to date. In Oregon dredging has not been always profitable, but it has been almost continuous since 1904, and in 1914 it was reported as notably

successful. In the Philippine Islands dredging had its inception under the Spanish régime in a curious native boat of diminutive scale but was first tried by modern American methods (unsuccessfully) in Masbate in 1905. Later New Zealand and American dredges were introduced into the Paracale-Mambulao district, southeastern Luzon, where the first native dredging was done, and the development of the industry has been continuous since. One modern dredge alone had recovered more than $450,000 in less than 2½ years to the end of 1914 and had paid 107 per cent interest on the original capitalization of $250,000. There were 8 dredges at work in 1914 in the islands, 7 in this district and 1 in Tayabas, and they produced altogether during the year about $515,000.

In California some of the earliest attempts at dredging for gold were made, following the first successful work of the kind with steam-driven bucket-elevator dredges at Otago, in New Zealand, in 1882. But it was not until 1896 that the first commercial bucket-elevator dredge of the California type was operated on Yuba River. It was later wrecked by floods, but it began the great output of gold from California by this method which had amounted to over $71,000,000 by the end of 1914, in which year 60 boats altogether were at work in the various fields. Much of the proved dredging ground in California has now been worked out, and it is an open question whether development of new ground will in the future take the place of that worked out. In the evolution of dredging apparatus from the small steam-driven wooden machines with buckets of a capacity of about 3 cubic feet each and capable of raising 1,200 cubic yards daily to the giant all-steel electric-driven dredges with buckets raising 16 cubic feet each and handling 10,000 cubic yards daily, California has earned first rank. It is becoming better known that a great deal of dredging in various parts of the world has been at a loss and that many important factors enter into the problem as to what ground can be worked at a profit by this method. The industry has now developed geologic, engineering, and constructing experts, and, in view of the fact that even profitable dredging is expensive in outlay, prospective investors would seem to gain something by consulting the rich fund of experience now available in the hands of these specialists.

Brief details of dredging operations have been given in Mineral Resources in the mines reports on gold, silver, copper, lead, and zinc of the Western States and also in earlier reports of the Director of the Mint. Further information is to be found in reports of geological surveys or mining officials of different States. A comprehensive and very useful report is contained in Bulletin 57 of the California State Mining Bureau, "Gold dredging in California," by W. B. Winston and Charles Janin. Another valuable treatise is "Dredging for gold in California," by D'Arcy Weatherbe, published by the Mining and Scientific Press; and additional information is constantly furnished by the technical press.

The following table, compiled from best available sources, gives the dredge production of gold in the United States and Alaska (not including the Philippine Islands) from 1896 to the end of 1914, inclusive, by States:

Production of gold in the United States by dredges and number of dredges producing, by States, 1896–1914.

State or Territory.	1914		1913		1912		1911		1910		1909		1908		1907		1906		1905	
	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.
Alaska	$2,350,000	42	$2,200,000	36	$2,200,000	38	$1,500,000	27	$800,000	18	$424,993	14	$170,901	4	$250,000	4	$120,000	3	$40,000	3
California	7,783,394	60	8,090,294	63	7,429,955	65	7,666,461	65	7,550,254	72	7,382,950	63	6,536,189	69	5,065,437	57	5,098,359	59	3,276,141	50
Colorado	602,655	5	372,288	4	384,748	3	272,173	4	344,211	6	404,636	4	141,773	4	35,235	3	48,343	3	33,342	3
Idaho	568,989	4	561,876	6	481,077	8	258,791	7	91,247	6	101,704	8	77,189	5	74,438	6	38,340	3	34,336	3
Montana	835,615	5	685,210	5	710,387	6	597,778	8	473,318	7	426,649	5	402,667	4	197,141	4	397,030	4	275,542	5
Oregon							14,575	3	34,010	6	42,667	2			23,191	2				
Other States	[a] 372,130	4	[b] 317,268	2	[c] 12,744	4	[d] 16,591	5					[e] 24,852	2	[f] 10,260	3	[g] 19,322	4	[h] 28,015	4
Total	12,512,783	120	12,226,936	116	11,218,911	124	10,326,369	119	9,293,040	115	8,783,599	96	7,353,571	88	5,655,702	79	5,721,394	76	3,687,376	68

State or Territory.	1904		1903		1902		1901		1900		1899		1898		1897		1896		Total value.
	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	Value.	Dredges.	
Alaska	$25,000	3	$20,000	2															$10,100,894
California	2,187,038	42	1,475,749	31	$867,665	29	$471,762	22	$200,929	16	$206,302	8	$18,887	3	$5,000	1	$2,000	1	71,314,766
Colorado	65,594	3	15,000	1	10,000	1	6,000	1											2,735,998
Idaho	99,110	7	86,113	6	101,257	10	116,117	6	129,443	6	62,436	5	13,920	1	11,436	1			2,907,819
Montana	245,700	2	229,332	4	318,914	7	146,134	5	189,665	5	165,440	5	154,893	4	102,120	4	42,000	1	6,595,535
Oregon																			[k] 114,443
Other States	[i] 101,275	4	[j] 89,870	1	[j] 71,686	1													[l] 1,064,013
Total	2,723,717	61	1,916,064	45	1,369,522	48	740,013	34	520,037	27	434,178	18	187,700	8	118,556	6	44,000	2	94,833,468

[a] Oregon, Nevada, Alabama, North Carolina.
[b] Oregon, Nevada.
[c] South Dakota, North Carolina, Georgia, Wyoming.
[d] Nevada (2), South Dakota, Georgia, North Carolina.
[e] Georgia, Oregon.
[f] Georgia (2), New Mexico.
[g] Georgia, Oregon.
[h] Georgia, North Carolina, Oregon, New Mexico.
[i] Oregon (3), New Mexico.
[j] New Mexico.
[k] Part of output only; see other States.
[l] Largely from Oregon.

DRY AND SILICEOUS ORES.

In 1914 dry and siliceous ores, including true gold, gold-silver, and silver ores, and precious metal ores not classed as primarily copper, lead, zinc, or mixed ores, produced $60,793,236 in gold, against $59,222,751 in 1913, or more than 66 per cent of the total output in each year. The largest producers from this class of ore are in order of rank: Colorado, California, Nevada, South Dakota, and Alaska.

The siliceous ores are in part free-milling (amalgamating), as in Alaska, California, and Oregon; in part both amalgamating and concentrating, as in many States; in smaller part simply concentrating ores, as in parts of Colorado and Arizona; in increasing part all-sliming and cyaniding ores; and finally in some part smelting ores. Tailings both from old dumps and from present milling are largely reworked by concentration and subsequent cyanidation.

The loss in tailings from gold mills is being constantly cut down, and the most serious present loss is in tailings from concentrating plants. The chlorination process is of decreasing relative importance. Smelting is mainly of concentrates and of siliceous and pyritic ores, which are also valuable as fluxes. Exact figures of relative output by methods will appear in detail by States in another table.

COPPER ORES.

The production of gold as a by-product of the smelting of copper ores sold or treated in 1914 was $5,474,559, against $5,697,855 in 1913, a decrease from 6.4 per cent of the total gold yield in 1913 to 6 per cent in 1914. The largest production was in Utah, followed by Arizona, Nevada, and Montana, in the order given.

LEAD ORES.

The production of gold from refining lead bullion from lead ores sold or treated in 1914, chiefly from Utah and Colorado, was $1,540,348, against $1,527,246 in 1913, or 1.7 per cent of the total domestic output of gold in each year.

LEAD-ZINC, ZINC, AND OTHER ORES.

The production of gold from lead-zinc ores was $360,746 in 1914, against $316,512 in 1913; from zinc ores $39,548 in 1914, against $18,528 in 1913; and from copper-lead and copper-lead-zinc ores $11,323 in 1914, against $97,094 in 1913.

DISTRIBUTION OF PRODUCTION OF SILVER IN 1914, BY SOURCES.

The mine production of silver from (1) dry or siliceous ores, (2) copper ores, and (3) lead ores combined, was 89 per cent of the total output against 91 per cent in 1913, 93 per cent in 1912, and 94 per cent in 1911. The output from lead-zinc ores increased from 7.5 per cent in 1913 to a little over 10 per cent in 1914.

The output from dry and siliceous ores increased 0.6 per cent in 1914, and that from lead ores increased 1.5 per cent, but that from copper ores decreased 4.3 per cent. The output from placers, zinc ores, copper-lead, and copper-lead-zinc ores is relatively insignificant.

The following table shows the sources of domestic production of silver by classes of ore, by States:

Source of mine production of silver in 1914 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama		199						199
Alaska	83,196	28,254	283,355					394,805
Arizona	241	1,133,976	2,604,371	493,226	34,691	31,991	79,498	4,377,994
California	34,877	268,828	703,042	465,112				1,471,859
Colorado	7,321	6,584,493	173,845	1,532,943	1,046	82,119	414,298	8,796,065
Georgia	29	38						67
Idaho	7,071	39,002	239,355	8,697,580	5,039		3,491,469	12,479,516
Illinois				2,112				2,112
Maryland and Virginia			1,502					1,502
Michigan			413,500					413,500
Missouri			14	61,154				61,168
Montana	7,041	1,249,555	8,015,694	388,194	48,373	5,271	2,302,332	12,016,460
Nevada	6,367	14,724,094	181,733	286,935	56,115	85,109	115,138	15,455,491
New Mexico	330	1,459,814	292,266	17,875		7,160		1,777,445
North Carolina	33	1,467	24					1,524
Oklahoma		6,187						6,187
Oregon	5,512	136,398		642				142,552
South Carolina		33						33
South Dakota	11	176,241		390				176,642
Tennessee			97,402					97,402
Texas		517,863	6,826				6,128	530,817
Utah	9	1,317,364	1,726,230	7,350,213		37,216	723,884	11,154,916
Washington	83	168,499	90,574	5,705				264,861
Wisconsin			16					16
Wyoming	7	30	79					116
Total	152,128	27,812,335	14,829,828	19,302,081	145,264	248,866	7,132,747	69,623,249
Value	$84,126	$15,380,221	$8,200,895	$10,674,051	$80,331	$137,623	$3,944,409	$38,501,656
Percentage of total	0.22	39.95	21.30	27.72	0.21	0.36	10.24	
Total, 1913	123,739	28,010,875	18,250,253	18,629,246	86,432	752,563	5,334,120	71,187,228
Value	$74,738	$16,918,569	$11,023,153	$11,252,065	$52,205	$454,548	$3,221,808	$42,997,086
Percentage of total	0.17	39.35	25.63	26.17	0.12	1.06	7.50	

[a] Philippines and Porto Rico not included in this table.

PLACERS.

The output of silver from the refining of placer gold was 152,128 fine ounces in 1914, against 123,739 ounces in 1913. The production is chiefly from Alaska and California.

DRY AND SILICEOUS ORES.

The mine production of silver from dry and siliceous ores in 1914 was 27,812,335 fine ounces, against 28,010,875 ounces in 1913. More than half of this was from Nevada (chiefly from the Tonopah district) and a large output was also made from Colorado (mainly from the Leadville, Upper San Miguel, and Sneffels districts). New Mexico, Arizona, and Utah also each produced more than 1,000,000 ounces of silver from this source.

A large part of the silver from gold-silver siliceous ores is obtained with the gold by amalgamation and cyanidation in the mills, and the silver is recovered by refining the mill bullion. The remainder is produced by smelting the richer ores and refining the copper or lead bullion produced.

COPPER ORES.

The mine production of silver from domestic copper ores in 1914 was 14,829,828 fine ounces, against 18,250,253 ounces in 1913 and 18,744,661 ounces in 1912. The decrease was largely due to curtailment of output of copper at some of the largest properties in the latter part of the year.

The production of silver from copper ores is from the electrolytic refining of Lake and blister copper produced by smelting. The copper ores are mainly sulphides (except the Lake ores of Michigan, which are native metal in amygdaloid and conglomerate matrix), and a greater tonnage contains chalcocite than chalcopyrite or cupriferous pyrite. The great disseminated copper deposits of Utah, Arizona, Nevada, and New Mexico are of increasing importance, and the lode deposits of Butte, Mont., have long been famous. The silver tenor of the extensive Chino disseminated deposits of the Santa Rita district, N. Mex., is notably low, but similar deposits elsewhere add large quantities of silver. Copper ores, especially sulphides, are mainly concentrated before smelting. Oxidized copper ores, sought for as fluxing ore and commonly smelted crude, still come from the Bisbee district of Arizona and the Tintic district of Utah.

In output of silver from copper ores Montana continued to lead with 8,015,694 ounces in 1914, against 10,311,809 ounces in 1913 and 10,655,055 ounces in 1912. Arizona followed with 2,604,371 ounces in 1914, against 2,885,115 ounces in 1913, and Utah ranked third with 1,726,230 ounces in 1914, against 2,314,348 ounces in 1913. California produced 703,042 ounces in 1914, against 833,672 ounces in 1913. The production of Montana is mainly form Butte, that of Arizona has been chiefly from Bisbee and Jerome, that of Utah from Tintic and Bingham, and that of California from Shasta County. Of these districts Bisbee well represents the disseminated type; Bingham produces from both lode and disseminated deposits; and the remainder produce silver chiefly from copper ore mined from deep lodes.

LEAD ORES.

The mine production of silver from argentiferous lead ores in 1914 was 19,302,081 fine ounces, against 18,629,246 ounces in 1913, a considerable increase in 1914 over 1913 and a notable increase over 1912 and 1911. The output from Idaho increased from 7,806,445 ounces in 1913 to 8,697,580 ounces in 1914, but that of Utah decreased from 7,537,361 ounces to 7,350,213 ounces, and that of Colorado from 1,645,186 ounces to 1,532,943 ounces. The yield in Idaho is mainly from the silver-lead ores of the Coeur d'Alene, that in Utah is chiefly from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. Most of the output is from the desilverization of lead bullion from smelting of western ores and concentrates.

ZINC, LEAD-ZINC, AND MIXED ORES.

Argentiferous zinc ores produced 145,264 ounces of silver in 1914, against 86,432 ounces in 1913, mainly as refinery by-products from the smelting of zinc concentrates from Nevada, Montana, and Arizona.

Lead-zinc ores produced 7,132,747 fine ounces of silver in 1914, against 5,334,120 ounces in 1913, chiefly from concentrates from the Coeur d'Alene in Idaho and the Butte district in Montana. It seems probable that the output of the Butte district will still further increase with the continued active mining and milling of the large zinc-lead ore bodies recently developed there. The output from both Idaho and Montana greatly increased in 1914.

Copper-lead and copper-lead-zinc ores produced only 248,866 ounces of silver in 1914, against 752,563 ounces in 1913. The output was mainly from Colorado and Nevada.

DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER BY METHODS OF TREATMENT.

In the following table is given a summary of the distribution of the production of gold and silver in the United States in 1914, showing (1) total crude ore, tailings, and slags sold or treated; (2) crude ore treated in gold and silver mills; (3) crude ore concentrated, with resulting concentrates; (4) crude ore shipped to smelters; (5) old tailings and slags treated. The last four items include recoverable gold and silver content in fine ounces.

Distribution of production of gold and silver in 1914, by methods of treatment, by States.[a]

State or Territory.	Total quantity of ore, tailings, and slag treated or sold in 1914.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates produced.		
		Quantity.	Gold in bullion.	Silver in bullion.	Quantity.	Quantity.	Gold.	Silver.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska	1,891,732	1,738,127	147,783	17,695	58,968	42,676	87,466	124,915
Arizona	8,009,927	312,753	116,881	617,049	5,384,083	460,338	15,391	423,982
California	2,465,485	1,993,821	414,081	140,194	.....	46,072	105,622	24,954
Colorado	2,677,526	1,630,640	612,144	676,231	378,743	188,770	116,263	2,058,557
Idaho	2,235,349	34,861	12,284	14,767	2,066,361	303,046	3,169	8,845,309
Montana	5,128,956	216,621	39,640	130,601	4,140,939	1,439,076	26,771	8,356,411
Nevada	4,522,022	1,461,577	439,919	12,100,494	2,768,193	467,686	41,686	1,721,348
New Mexico	2,232,853	156,913	29,731	1,161,455	1,955,881	161,003	12,754	312,734
Oklahoma	190	.....	.....	.....	.....	.....	.....	.....
Oregon	124,331	106,422	44,880	53,454	12,815	1,439	4,877	70,112
South Dakota	2,019,262	2,017,882	351,865	172,574	.....	.....	.....	.....
Texas	42,270	40,375	.....	517,863	1,640	475	11	6,128
Utah	8,544,014	2,166	739	11,614	7,523,339	500,458	51,745	2,114,993
Washington	95,947	24,533	8,432	41,504	13,581	1,589	95	42,443
Wisconsin	37	.....	.....	.....	.....	.....	.....	.....
Wyoming	423	338	130	25	.....	.....	.....	.....
Eastern or Appalachian States	688,938	24,307	6,309	1,311	1,961	396	770	378
Total	40,679,262	9,761,336	2,224,518	15,656,831	24,306,504	3,613,024	466,620	24,102,264
Total 1913	43,984,220	9,261,899	2,179,348	14,492,424	27,088,716	3,786,031	473,788	24,045,495

[a] Exclusive of small quantity of silver from copper ores in Michigan and Missouri and from lead ores in Missouri and Illinois.

Distribution of production of gold and silver in 1914, by methods of treatment, by States—Continued.

State or Territory.	Crude ore to smelter.			Old tailings and slag treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska	94,637	8,283	168,999			
Arizona	2,238,808	68,238	3,280,667	74,283	[a] 199	[a] 56,055
California	449,132	36,188	1,267,752	22,532	3,936	4,082
Colorado	668,143	202,364	6,053,956			
Idaho	130,512	6,406	3,612,369	3,615	[b]	[b]
Montana	700,098	87,213	3,522,407	[c] 71,298	[b]	[b]
Nevada	261,018	55,375	1,600,315	31,234	[d] 172	[d] 26,967
New Mexico	120,059	12,786	302,926			
Oklahoma	190		6,187			
Oregon	4,594	663	13,469	500	42	5
South Dakota	1,380	2,825	4,057			
Texas	255		6,826			
Utah	910,308	105,228	8,721,461	108,201	190	306,839
Washington	57,833	18,148	180,831			
Wisconsin	37		16			
Wyoming	85	23	84			
Eastern or Appalachian States.	655,129	373	98,919	7,541	341	57
Total	6,292,218	604,113	28,841,211	319,204	4,880	394,005
Total 1913	7,109,088	568,064	31,436,284	524,517	14,119	491,270

[a] Gold and silver from 26,882 tons of old tailings included under recoveries from gold and silver mills.
[b] Included under ore sent to gold and silver mills.
[c] Includes 3,393 tons of copper ore leached in Arizona; includes 56,655 tons copper ore leached in Montana.
[d] Gold and silver from 29,168 tons of these tailings are included under recoveries from gold and silver mills.

The first item consists of all classes of ores, tailings, and slags from which gold and silver was produced in 1914. The grand total is 40,679,262 short tons in 1914, against 43,984,220 tons in 1913. This takes no account of placer gravel but represents output of mines producing ore only. The greatest output was from Utah, Arizona, Montana, and Nevada, all notable for large yield of copper ores.

In reference to the second item many gold and silver mills employ concentrating apparatus, and the concentrates produced are combined in the table with those from straight concentrating mills under the heading "concentrates produced." The gold and silver recovery under this item is mainly by amalgamation and cyanidation, as is shown in detail in the last table of this report. The total quantity of crude ore treated in gold and silver mills in 1914 was 9,761,336 short tons, against 9,261,899 tons in 1913, and was the largest quantity so treated since these figures were first compiled by the Survey for 1910. The greatest tonnages milled were in South Dakota, California, Alaska, Colorado, and Nevada. The total recovery of gold from the mills was 2,224,518 fine ounces in 1914, against 2,179,348 ounces in 1913, and the production was as usual, chiefly from Colorado, Nevada, California, and South Dakota, in the order named. The total silver recovery in mills was 15,656,831 fine ounces against 14,492,424 ounces in 1913, and came very largely from Nevada—from Tonopah and Goldfield chiefly, but also in considerable part from New Mexico, Colorado, and Arizona.

Under the third item is given the quantity of ore treated by concentration only, including the large quantities of copper, lead, zinc, and mixed ores, whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper and

lead bullion and smelting the zinc residues. Examples are the copper ores of the disseminated deposits of Bingham, Utah, the copper ores of Butte, Mont., the lead and lead-zinc ores of Cœur d'Alene, Idaho, Butte, Mont., and Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content, however, as already stated, represent not only the concentrates from these straight concentrating mills but also those from gold and silver mills. These concentrates are mainly smelted but are in some cases treated in gold and silver mills by the processes named. The tonnage treated in straight concentration mills decreased from 27,088,716 short tons in 1913 to 24,306,504 tons in 1914, mainly because of the curtailment of activity at copper mines. Utah ranked first in quantity of ore concentrated, followed by Arizona, Montana, Nevada, Idaho, and New Mexico. These tonnages, with the exception of those of Montana and Idaho, represent largely tonnages of low-grade disseminated copper ores milled. The total quantity of gold and silver-bearing concentrates from all classes of milling ore decreased from 3,786,031 short tons in 1913 to 3,613,024 tons in 1914. Montana mills produced the largest quantity of concentrates followed by those of Utah, Nevada, Arizona, and Idaho. The total recoverable gold content of all concentrates was 466,620 ounces in 1914, against 473,788 in 1913, and came mainly from Colorado, California, Alaska, Utah, and Montana, in the order named. The total recoverable silver from concentrates produced was 24,102,264 fine ounces in 1914, against 24,045,495 ounces in 1913, and came chiefly from Idaho, Montana, Utah, Colorado, and Nevada.

The fourth item covers the quantity and the recoverable precious-metal content of crude ores shipped from the mines direct to the smelters, and in general includes the richer gold, silver, copper, lead, and mixed ore from which the gold and silver is eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. The total quantity shipped of this class of ore decreased from 7,109,088 short tons in 1913 to 6,292,218 tons in 1914. The output was notably from Arizona, followed by Utah, Montana, Colorado, Eastern or Appalachian States, California, and Nevada in the order named. The total yield of gold from crude ores smelted increased from 568,064 fine ounces in 1913 to 604,113 ounces in 1914, and came chiefly from Colorado, Utah, Montana, Arizona, and Nevada in the order given. The total recoverable silver output decreased from 31,436,284 fine ounces in 1913 to 28,841,241 ounces in 1914 and was notably from Utah, Colorado, Idaho, Montana, and Arizona.

Under the fifth item is given the quantity of old materials, principally tailings and slags, re-treated, and their recoverable contents. These are partly smelted, often for their fluxing as well as their metal value; but considerable quantities of old tailings are now concentrated and cyanided, and impounding of mill tailings for future treatment as well as because of legal requirements has now become a general practice. The total quantity of all old material treated as shown in the table decreased from 524,517 short tons in 1913 to 319,204 tons in 1914, and the recoverable content of gold decreased from 14,119 to 4,880 ounces, and that of silver decreased from 491,270 to 394,005 ounces. The silver yield was largely from Utah.

From this table the output of ore from the Central States, producing small quantities of silver and no gold, has been omitted. The output of zinc ore from the Eastern States is also omitted, as this zinc ore is reported to produce neither silver nor gold.

The following table shows in summary the percentage of total output, by processes, of gold and silver in 1912, 1913, and 1914:

Percentage of output of gold and silver by processes in the United States in 1912, 1913, and 1914.

Production by—	Percentage of total output.					
	Gold.			Silver.		
	1912	1913	1914	1912	1913	1914
Placers	24.8	24.9	25.3	0.2	0.2	0.2
Gold and silver mills:						
By amalgamation	22.3	21.5	20.9	1.2	.6	.4
By cyanidation	30.9	31.2	31.4	17.8	19.7	22.1
By chlorination	.4	.3	.2	.....	.....	.....
Total milling	53.6	53.0	52.5	19.0	20.3	22.5
Smelting[a]	21.6	22.1	22.2	80.8	79.5	77.3
Total[b]	100.0	100.0	100.0	100.0	100.0	100.0

[a] Both crude ore and concentrates. [b] Philippine Islands and Porto Rico excluded.

The placers produced one-fourth of the total output of gold and, in percentage, show a small but steady increase during the last three years, owing both to slight decrease in some of the large lode mines and to an increased yield by dredging. The percentage of output of silver credited to the placers is insignificant.

In the mills the amalgamation process has given steadily decreasing production of gold and silver, the chlorination process has almost ceased to produce gold, but the cyanidation process each year has given increased proportion of the total production of both gold and silver. Altogether the mills show a proportionate decrease in gold and an increase in silver, and in 1914 they produced 52.5 per cent and 22.5 per cent of gold and silver, respectively.

The smelters have been producing each year a slightly greater proportion of gold and a smaller proportion of silver and are to be credited in 1914 with 22.2 per cent of the total output of gold and 77.3 per cent of the silver.

The bulk of the output of silver, however, is still from the smelting of crude ore, concentrates, and other material, but in decreasing ratio as the ratio of output from cyanidation increases. The bulk of the gold output is also mainly still from the gold mills, but in decreasing proportion, for although the output from cyanidation increases it does not offset the decrease by amalgamation and chlorination and the increase from placers and from the smelting of crude ores and concentrates.

The following table shows in greater detail the ore treated and the output of gold and silver mills, by States, in 1914:

Quantity of ore treated at gold and silver mills in 1914, giving recoveries by amalgamation and cyanidation and percentage of production by each to gold and silver recovered from all sources.[a]

State.	Ore and tailings treated.	Bullion recovered.				Percentage of gold and silver from all sources.			
		Amalgamation.		Cyanidation.		Amalgamation.		Cyanidation.	
		Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*				
Alaska	1,738,127	144,625	18,062	90,363	9,561	18.8	4.6	11.8	2.4
Arizona	339,635	12,532	3,014	104,349	614,035	6.2	.1	51.6	14.0
California[b]	1,993,821	353,386	84,421	64,630	59,855	35.4	5.7	6.5	4.1
Colorado[b]	[c]1,630,640	87,232	52,295	517,243	623,916	9.1	.2	53.8	7.1
Idaho	37,971	9,339	4,878	2,945	9,889	16.8	.04	5.3	.08
Montana	222,218	3,865	1,642	35,776	128,959	2.0	.....	18.0	1.1
Nevada	1,490,745	68,879	38,714	371,040	12,061,780	12.4	.4	66.8	78.5
New Mexico	156,913	5,945	1,199	23,786	1,160,256	10.5	.1	42.0	65.2
Oregon	106,422	16,146	2,599	28,776	50,861	21.0	1.7	37.4	35.7
South Dakota	[d]2,017,882	218,644	63,734	133,221	108,840	61.6	36.1	36.7	61.6
Texas	40,375	.....	.....	.....	517,863	.....	.....	.....	97.5
Utah	17,666	106	78	633	11,536	.06	.05	.4	.1
Washington	24,533	829	255	7,602	41,249	3.1	.1	28.2	15.6
Wyoming	338	130	25	.....	.....	54.1	21.5	.....	.....
Appalachian States	31,799	2,595	501	4,571	1,236	30.9	.5	54.4	1.2
Total, 1914.	9,849,085	924,253	271,417	1,384,935	15,399,836	20.9	.4	31.4	22.1
Value[e]	.....	$19,106,005	$150,093	$28,629,147	$8,516,110	.....	.....	.....	.....
Total, 1913.	9,401,856	927,572	428,844	1,348,322	14,090,407	21.3	.6	31.0	19.8
Value	.....	$19,174,615	$259,022	$27,872,289	$8,510,606	.....	.....	.....	.....

[a] Porto Rico and Philippine Islands excluded.
[b] Recovered by chlorination 15,819.5 ounces of gold in California and 7,668.5 ounces in Colorada; and silver recovered by chlorination, 2,510 ounces in California and 20 ounces in Colorado.
[c] 1,263,867 tons of crude ore tailings and concentrates first treated by amalgamation, then by cyanidation.
[d] 1,568,315 tons of tailings treated by cyanidation after being treated by amalgamation.
[e] Value of gold recovered by chlorination,.$485,540; value of silver, $1,399.

Figures corresponding to those in this table were collected and compiled for the entire United States by the Survey for the first time in 1911, and comparison for four years can therefore now be made.

The total quantity of crude ore treated and old tailings re-treated in gold and silver mills in 1914 was 9,849,085 short tons in 1914, against 9,401,856 tons in 1913, against 9,677,360 tons in 1912, and 9,670,483 tons in 1911.

The great bulk of the ore treated, as shown, was milled in South Dakota, California, Alaska, Colorado, and Nevada, in the order named, and here the famous mills of the Homestake, Mother Lode and Grass Valley, Treadwell, Cripple Creek, Tonopah, and Goldfield mines are especially in evidence. Large numbers of smaller mills, however, mark the wide distribution, of gold mining especially, in nearly every mountain range. These plants range from small prospecting mills with from 1 to 3 light stamps, simple amalgamating apparatus, and usually no concentrating apparatus, through the conventional 5-stamp, 10-stamp, 15-stamp, and 20-stamp mills—with plants varying widely, according to characteristics of local ore, in weight and drop of stamps, rapidity and fineness of discharge, and arrangement for amalgamation, concentration, and cyanidation—to the great mills above mentioned, which treat enormous quantities of

ore daily and represent the high-water mark in milling and metallurgy of the precious metals.

The ore treated in gold and silver mills, with increase and decrease for 1914, has been noted in connection with a preceding table.

The total yield of gold by amalgamation in the United States in 1914 was 924,253 fine ounces, valued at $19,106,005, against 927,572 ounces, valued at $19,174,615, in 1913. The output in 1914 was 353,386 ounces in California, 218,644 ounces in South Dakota, 144,625 ounces in Alaska, 87,232 ounces in Colorado, and 68,879 ounces in Nevada.

The total yield of silver by amalgamation in 1914 was only 271,417 fine ounces, valued at $150,093, against 428,844 ounces, valued at $259,022, in 1913. The output was mainly from California, South Dakota, Colorado, and Nevada, in the order given, and was chiefly of silver alloyed with gold. The production of Texas ranked first in 1914, but since the extraction process at the Presidio silver mine has been changed from amalgamation to cyanidation the yield by the former process has practically ceased in that State.

The total output of gold by cyanidation in 1914 was 1,384,935 fine ounces, valued at $28,629,147, against 1,348,322 ounces, valued at $27,872,289, in 1913. The output was 517,243 ounces in Colorado, 371,040 ounces in Nevada, 133,221 ounces in South Dakota, 104,349 ounces in Arizona, 90,363 ounces in Alaska, and 64,630 ounces in California in 1914.

The total silver yield by cyanidation in 1914 was 15,399,836 fine ounces, valued at $8,516,110, against 14,090,407 ounces, valued at $8,510,606, in 1913. Nevada led, with the bulk of the output—12,061,780 ounces—and was followed by New Mexico with 1,160,256 ounces, Colorado with 623,916 ounces, Arizona with 614,035 ounces, and Texas with 517,863 ounces.

Of the gold-producing States whose chief output is from milling ores, Alaska, California, and South Dakota still yield more gold by amalgamation than by cyanidation, whereas the latter process produces more gold than amalgamation in Arizona, Colorado, and Nevada; and it produces much more silver in Arizona, Colorado, Montana, Nevada, New Mexico, South Dakota, and Texas. Altogether amalgamation produced gold and silver valued at $19,256,098 from milling ores in 1914, against $37,145,257 produced by cyanidation from such ores in that year.

Of the total output of gold from all sources in 1914, amalgamation produced 18.8 per cent in Alaska, 35.4 per cent in California, and 61.6 per cent in South Dakota, and cyanidation produced 51.6 per cent in Arizona, 53.8 per cent in Colorado, 66.8 per cent in Nevada, 42 per per cent in New Mexico, and 36.7 per cent in South Dakota.

Of the total output of silver from all sources in 1914 amalgamation produced 36.1 per cent in South Dakota, and cyanidation produced 78.5 per cent in Nevada, 65.2 per cent in New Mexico, 61.6 per cent in South Dakota, and 97.5 per cent in Texas.

For details of the consumption of quicksilver in the amalgamation milling process and of potassium sodium cyanide in the cyanidation process the reader is referred to the mines reports of the several Western States indicated in the prefatory note. Data as to consumption of these supplies are not yet furnished by a sufficient number of mining and milling companies to justify tabulation for

the entire United States. It seems certain, however, that of late years the quantity of quicksilver consumed in the amalgamation process has been greatly overestimated. In the writer's report on quicksilver, in Mineral Resources for 1914, he estimates that only 87,181 pounds of quicksilver were thus consumed in 1913, against 89,675 pounds in 1912 and 96,783 pounds in 1911. This indicates a use of only 1,150 to 1,290 flasks, or about 8 per cent of the domestic output of quicksilver. Since the outbreak of the European war a shortage of potassium cyanide developed, owing to the difficulty of importation from Germany and the need of practically all the English output for the Rand mines in South Africa. Even before the war, however, plans were made for increased output and use of sodium cyanide and this could be produced in greater quantity in this country if future conditions warranted. The consumption of these cyanides in three of the Western States is shown in the following table:

Consumption of potassium and sodium cyanides in certain Western States in 1913 and 1914, in pounds.

	Potassium cyanide.		Sodium cyanide.	
	1913	1914	1913	1914
Colorado	659,374	35,800	260,589	935,589
New Mexico	1,415	.....	190,190	237,511
South Dakota	113,727	89,649	388,961	425,397
Total	774,516	125,449	839,740	1,598,497

These figures indicate the increasing trend toward the substitution of sodium cyanide for potassium cyanide.

It is hoped to publish complete tables of the consumption of quicksilver and the cyanides in the precious-metal milling plants of the United States in the next report.

ZINC.

(GENERAL REPORT.)

By C. E. Siebenthal.

INTRODUCTION.

The preliminary estimate of the production of primary [1] spelter usually given out in the form of a press bulletin on January 2 was necessarily omitted for 1914 because of the refusal of several smelters to report their production and stocks. The advance statement giving the final figures of production and consumption of spelter was published March 25, 1915. The midyear statement of production and consumption of spelter during the first six months of 1915 was published August 26, 1915. It gave a list of smelters brought up to date and of the new plants under construction and contemplated, several tables of exports of zinc and of manufacture of zinc by months, and showed the results of the stimulus of the war on the zinc industry of the United States by six-month periods. These tables are repeated on a later page.

The present report includes the figures given out in the advance statement and contains in addition tables of imports and exports of spelter and of zinc ore, a comparison of mine and smelter returns, a list of zinc smelters, a brief review of the advance in metallurgy and ore dressing as applied to zinc ores, and finally, a summary of the domestic and foreign conditions of the zinc industry, including a section on the especial effects of the war.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each zinc smelting company in operation during 1914.

Statistics of the recovery of secondary zinc were collected from all the important secondary smelters and refiners. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and the tables for foreign production and consumption were compiled from the sources indicated.

STATE OF ZINC INDUSTRY IN 1914.

The production of primary spelter from domestic ores in 1914 was 343,418 short tons, valued at $35,028,636, based on the average St. Louis price, as compared with 337,252 short tons, valued at

[1] In Mineral Resources for 1906, p. 461, zinc derived from ore was called "primary" spelter to distinguish it from the secondary spelter recovered from such sources as drosses, skimmings, and old metal. The former has also been called "virgin" spelter, and the latter has been called "remelted," "reclaimed," and "dross" spelter. The distinctive origin is more plainly suggested by the terms "primary" spelter and "secondary" spelter, and they are used herein. The terms have no reference whatever to the qualities of the product. Where the word "spelter" is used without qualification, primary spelter will be understood.

$37,772,224, based on the average St. Louis price in 1913—an increase of 6,166 tons, equal to about 2 per cent in quantity and a decrease of $2,743,588, equal to 7 per cent, in value.

The total production of spelter from both domestic and foreign ores in 1914 was again the largest in the history of the zinc-smelting industry of the United States, being 353,049 tons, as against 346,676 tons in 1913, an increase of 6,373 tons, or about 2 per cent. The domestic consumption was below normal, so that the stocks of 40,569 tons at the beginning of the year had increased to 64,039 tons at the middle of the year. The war in Europe, which resulted in practically shutting off their previous supplies of spelter from the allies, soon led to larger exports from the United States, which amounted to 72,542 tons during the latter half of the year, and the large spelter stocks were reduced to 20,095 tons at the close of the year.

If the average annual capacity of a retort were four tons of spelter, the production of spelter in 1914 would represent the output of 88,262 retorts, running steadily through the year. A canvass of the zinc smelters in December, 1913, showed 85,051 retorts then in operation on ore; there were 94,468 retorts effective for ore at the close of 1914. The mean of these two numbers would give 89,760 retorts as operating in 1914, which is very close to the number reached from the assumed retort capacity.

PRODUCTION.

ANNUAL PRODUCTION 1873–1914.

The production of spelter in the United States began in 1858 in an experimental way[a] and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiesson & Hegeler works in the West. Between 1864 and 1870 nine or ten other zinc smelters were established. Statistics of production are recorded for the years 1873 and 1875 and for the census year ending May 31, 1880. Annual statistics have been collected by the United States Geological Survey since 1882. The annual progress of the zinc-smelting industry since 1873 is shown in the following table:

Annual production of spelter in the United States from domestic and foreign ores, 1873–1914, in short tons.

Year.	From foreign ore.	From domestic ore.	Total.	Year.	From foreign ore.	From domestic ore.	Total.
1873	.....	7,343	7,343	1897	.....	99,980	99,980
1875	.....	15,833	15,833	1898	.....	115,399	115,399
1880 (census)	.....	23,239	23,239	1899	.....	129,051	129,051
1882	.....	33,765	33,765	1900	.....	123,886	123,886
1883	.....	36,872	36,872	1901	.....	140,822	140,822
1884	.....	38,544	38,544	1902	.....	156,927	156,927
1885	.....	40,688	40,688	1903	.....	159,219	159,219
1886	.....	42,641	42,641	1904	.....	[b]186,702	186,702
1887	.....	50,340	50,340	1905	.....	[b]203,849	203,849
1888	.....	55,903	55,903	1906	25,076	199,694	224,770
1889	.....	58,860	58,860	1907	26,115	223,745	249,860
1890	.....	63,683	63,683	1908	19,675	190,749	210,424
1891	.....	80,873	80,873	1909	25,535	230,225	255,760
1892	.....	87,260	87,260	1910	16,705	252,479	269,184
1893	.....	78,832	78,832	1911	14,905	271,621	286,526
1894	.....	75,328	75,328	1912	14,899	323,907	338,806
1895	.....	89,686	89,686	1913	9,424	337,252	346,676
1896	.....	81,499	81,499	1914	9,631	343,418	353,049

[a] Ingalls, W. R., Lead and zinc in the United States, p. 314.
[b] Including an unknown quantity smelted from foreign ore, small in 1904, but larger in 1905.

PRODUCTION BY STATES.

Production of primary spelter in the United States in 1906–1914, apportioned according to source of ore, in short tons.

Source.	Quantity.								
	1906	1907	1908	1909	1910	1911	1912	1913	1914
Arizona	64	77	152	2,862	2,594	2,476	4,092	4,675	3,905
Arkansas	1,801	1,911	2,002	135	286	385	604	478	670
California	.....	140	27	.....	.....	959	1,672	1,012	159
Colorado	32,456	26,077	24,885	20,121	23,238	42,233	60,841	58,113	41,746
Idaho	573	3,508	581	901	3,454	3,180	6,800	10,190	22,720
Illinois	282	1,446	298	675	1,551	2,884	3,952	1,345	1,833
Iowa	201	220	516	.....	40	.....	.....	.....	.....
Kansas	3,902	13,850	8,628	9,185	10,220	6,843	5,668	9,956	10,634
Kentucky	335	358	341	22	29	205	394	172	147
Maine	.....	1	.....	.....	.....	.....	.....	.....	.....
Missouri	130,348	141,824	123,655	140,676	140,652	127,540	149,557	129,018	114,019
Montana	1,415	.....	900	4,725	12,408	22,115	14,196	35,604	55,986
Nevada	1,768	1,692	398	825	1,516	1,595	6,132	5,828	6,041
New Jersey	11,206	13,573	6,926	16,035	20,217	15,128	16,941	24,247	27,734
New Mexico	555	136	134	3,961	4,911	3,778	6,882	3,765	4,345
North Carolina	.....	.....	.....	.....	.....	.....	.....	152	.....
Oklahoma	.....	719	2,235	3,008	2,297	2,247	2,041	6,397	9,449
Tennessee	124	181	341	695	925	1,000	1,935	2,635	6,122
Texas	8	16	.....	.....	.....	.....	245	303	156
Utah	2,449	1,972	282	5,960	7,221	7,004	7,756	9,503	6,818
Virginia	1,143	771	910	58	1,168	228	62	116	20
Washington	7	.....	.....	.....	.....	12	.....	.....	.....
Wisconsin	11,057	15,273	17,538	20,381	19,752	31,809	34,137	33,743	30,914
Total from domestic ores	199,694	223,745	190,749	230,225	252,479	271,621	323,907	337,252	343,418
Foreign:									
Canada	201	545	2,425	978	3,304	1,598	4,199	1,424	4,538
Mexico	24,875	25,570	17,250	24,557	13,401	13,307	10,700	6,205	5,093
Europe	.....	.....	.....	.....	.....	.....	.....	1,175	.....
Russia (Siberia)	.....	.....	.....	.....	.....	.....	.....	620	.....
Total from foreign ores	25,076	26,115	19,675	25,535	16,705	14,905	14,899	9,424	9,631
Grand total	224,770	249,860	210,424	255,760	269,184	286,526	338,806	346,676	353,049

Two tabulations of the spelter production of the country for a period of years are given, one showing the locality from which the ores were derived, the other the locality in which they were smelted. Each method has its special interests and advantages, dependent on whether the viewpoint be that of producer or consumer or that of resources.

The State totals as given are compiled entirely from confidential reports by each company engaged in smelting zinc ores in the United States in the year in question. Only primary spelter is here included, the recovery of secondary spelter being given in a later table.

The foregoing table shows the sources of all ores and concentrates smelted for spelter in the United States in 1906–1914 and the quantity of spelter actually derived from the ores from these respective sources. Statistics of production according to source of ore were not collected prior to 1906.

The subjoined table shows the localities in which spelter was made:

Production of spelter in the United States, 1873–1914, apportioned according to locality in which smelted, in short tons.

Year.	Illinois.	Kansas.	Missouri.	Oklahoma.	Eastern.	Southern.	Colorado.	Total.
1873								7,343
1875	6,678	600	4,650		3,305			[a] 15,833
1880 (census)	10,904	2,451	5,671		4,213			23,239
1882	18,201	7,366	2,500		5,698			33,765
1883	16,792	9,010	5,730		5,340			36,872
1884	17,594	7,859	5,230		7,861			38,544
1885	19,427	8,502	4,677		8,082			40,688
1886	21,077	8,932	5,870		6,762			42,641
1887	22,279	11,955	8,660		7,446			50,340
1888	22,445	10,432	13,465		9,561			55,903
1889	23,860	13,658	11,077		10,265			58,860
1890	26,243	15,199	13,127		9,114			63,683
1891	28,711	22,747	16,253		8,945	4,217		80,873
1892	[b] 31,383	24,715	16,667		9,582	4,913		87,260
1893	[b] 29,596	22,815	13,737		8,802	3,882		78,832
1894	[b] 28,972	25,588	11,992		7,400	1,376		75,328
1895	[b] 35,732	25,775	14,998		9,484	3,697		89,686
1896	[b] 36,173	20,759	14,001		8,139	2,427		81,499
1897	[b] 37,876	33,396	18,125		7,218	3,365		99,980
1898	[b] 47,103	40,132	19,533		8,631			115,399
1899	[b] 50,118	52,021	18,107		8,805			129,051
1900	[b] 38,750	62,136	14,741		8,259			123,886
1901	[b] 44,896	74,240	13,083		8,603			[a] 140,822
1902	[b] 47,096	86,564	11,087		12,180			[a] 156,927
1903	[b] 47,659	88,388	9,994		12,301		877	[a] 159,219
1904	47,740	107,048	12,150		14,893		4,871	[a] 186,702
1905	46,606	114,287	11,844		24,513		6,599	[a] 203,849
1906	47,939	129,564	11,077		29,930		6,260	224,770
1907	56,056	134,108	11,732	5,035	37,626		5,303	249,860
1908	50,244	99,298	10,201	14,864	32,738		3,079	210,424
1909	67,653	103,299	7,037	28,782	42,941		6,048	255,760
1910	73,038	105,697	5,571	34,760	43,606		6,512	269,184
1911	83,130	98,413	4,116	46,315	47,155		7,397	286,526
1912	88,397	101,104	7,085	76,925	56,252		9,043	338,806
1913	106,654	74,106	5,085	83,214	69,063		8,554	346,676
1914	127,946	44,510	3,550	91,367	77,593		8,083	353,049

[a] Secondary spelter included: 600 tons in 1875; 2,716 tons in 1901; 2,675 tons in 1902; 3,302 tons in 1903; 3,300 tons in 1904; and 1,469 tons in 1905.
[b] Includes also the production of smelters in Indiana.

In view of the fact that this chapter can not be prepared for publication until late in the year, after the figures for the midyear spelter statement are available, those figures have been utilized in the following table, showing the production by States for six-month periods, though they include one six-month period later than the volume for the year:

Production of spelter in the United States, 1911–1915, by six-month periods, apportioned according to locality in which smelted, in short tons.

	Illinois.	Kansas.	Oklahoma.	All other States.	Total.
1911:					
First half	41,255	50,574	19,997	28,370	140,196
Second half	41,875	47,839	26,318	30,298	146,330
1912:					
First half	44,224	52,485	36,010	33,777	166,496
Second half	44,173	48,619	40,915	38,603	172,310
1913:					
First half	53,524	42,645	43,253	40,791	180,213
Second half	53,130	31,461	39,961	41,911	166,463
1914:					
First half	62,062	23,737	45,443	43,816	175,058
Second half	65,884	20,773	45,924	45,410	177,991
1915:					
First half	74,982	35,247	51,172	55,131	216,532

ZINC DUST.

Zinc dust is an impalpable powder which forms in the distillation of zinc when the zinc vapor is cooled too rapidly in the condensers or is diluted by too large a volume of other gas. It may constitute a large proportion of the metallic zinc obtained in electrothermic zinc smelting, but in ordinary retort smelting it usually amounts to between 3 and 10 per cent of the reduced zinc. The powder consists of metallic zinc with about 10 per cent zinc oxide, which probably exists as a film surrounding the metallic particles. These particles can not be made to coalesce by heating unless under great pressure, but must be again vaporized and condensed. Marketable zinc dust must not contain more than 10 per cent of zinc oxide and must pass through a screen of 100 meshes to the inch.

Zinc dust differs from metallic zinc in other physical properties, such as rapid oxidation, absorption of hydrogen, and generally greater chemical activity, resulting at times in spontaneous combustion or explosion. These properties are believed by Sang [1] to be due to conditions of stress resulting from rapid solidification, somewhat analogous to the condition in "Prince Rupert's drops."

These peculiar properties of zinc dust are the cause of many of its uses. Under the name of "indigo auxiliary" a paste of zinc dust is used to discharge locally the color in dyeing cotton goods, giving a white pattern on the background of dye. Zinc dust is used in fireworks and in making hydrogen for balloons. It is the basis of the various methods of dry galvanizing and is also used to furnish the zinc solution in electrozincing. One of the most important uses of zinc dust is as a substitute for zinc shavings in zinc precipitation in the cyanide treatment of gold and silver ores. For this purpose it is cheaper, quicker, more effective, and more convenient than zinc shavings, and the saving in cost is about one-third.

In American zinc-smelting practice, heretofore the zinc dust has been charged back into the retorts, as under the former tariff if sold as dust it came into competition with foreign zinc dust admitted free of duty, whereas recovered as spelter it was protected by an import duty of $1\frac{1}{2}$ cents per pound. Hence the small quantity of zinc dust heretofore used in this country has been imported from Belgium and Germany. The tariff act of 1909 established an import duty upon zinc dust of $1\frac{3}{8}$ cents per pound, and the tariff act of 1913 changed this to 15 per centum ad valorem.

A ruling of the Interstate Commerce Commission lists zinc dust and zinc flue dust as inflammable solids and directs that they must bear a yellow shipping label. Paragraph 1834 of the ruling covering this product reads as follows: "Packages must be tight and strong, and the interior packages must be so cushioned and secured that no rupture of either package can result from the ordinary shocks incident to transportation."

The early market for zinc dust was mainly western, the use being for zinc-dust precipitation in cyaniding in South Dakota, Nevada, and elsewhere. More recently the sherardizing process of galvanizing has created a market for zinc dust in the eastern part of the country.

[1] Sang, Alfred, Old and new methods of galvanizing: Eng. Soc. Western Pennsylvania Proc., vol. 23, pp. 546–571, 1907.

Numerous wet methods for the recovery of zinc from complex sulphide ores are now under investigation. Most of these require the precipitation of gold, silver, copper, and lead from solution by zinc dust, the zinc being recovered from solution by electrolysis. The successful establishment of these processes in commercial practice will create a further large demand for zinc dust.

Zinc dust has been made in the United States since the middle of 1910 when the United States Zinc Co. began preparing it for the market at the smelter at Pueblo, Colo. The Grasselli Chemical Co. later followed suit, and one by one other companies began to save zinc dust until in 1914 the companies named below reported production. Many of these companies saved zinc dust for the first time in 1914, being led thereto by the high price of zinc dust consequent upon the inability of Belgium and Germany to export any to the United States.

Zinc smelters that prepared zinc dust for market in 1914.

Clarksburg Zinc Co., Clarksburg, W. Va.
Grasselli Chemical Co., Clarksburg, W. Va.
Mineral Point Zinc Co., Depue, Ill.
National Zinc Co., Bartlesville, Okla.
New Jersey Zinc Co., Palmerton, Pa.
Prime Western Spelter Co., Gas, Kans.
United States Zinc Co., Pueblo, Colo.

The following table gives the output of zinc dust since its first production in a commercial way in the United States:

Production of zinc dust in the United States, 1910–1914.

	Pounds.		Pounds.
1910	137,700	1913	846,000
1911	508,000	1914	2,007,735
1912	984,000		

As will be seen from the table of imports of zinc dust given on a later page, the quantity imported in 1914 was still large, notwithstanding the increase in domestic production. During 1915, however, the imports from Belgium and Germany have entirely ceased and the domestic output must have correspondingly increased.

ZINC PIGMENTS.

There are four white pigments which have zinc for a base, either in whole or in part—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. All of these may be, and in the United States the first three usually are, made directly from ore.

Zinc oxide is the most important of these pigments. In European practice the oxide is made from spelter, though in France zinc oxide is made from ore in the electrothermic furnace invented by Côte and Pierron. In the United States the oxide is generally made from ore, but included in 1914 the total production 6,100 tons made from spelter, as compared with 5,700 tons in 1913. The production of zinc oxide in 1911–1914 may not be disclosed. In 1910 it was 59,333 short tons, as compared with 68,974 tons in 1909 and with 57,237 tons in 1908. The imports of zinc oxide for consumption in 1914 were 3,433 short tons, and the exports for the same period were 14,467 short tons.

Leaded zinc oxide and zinc-lead oxide are produced from ore, both in some places at the same plant, the zinc-lead containing somewhat the larger percentage of lead. No zinc-lead oxide has been made since 1909. The production of leaded zinc pigment in 1911–1914 may not be disclosed, but in 1910 it was 7,111 short tons.

Lithopone is an intimate mixture by chemical precipitation of zinc sulphide and barium sulphate. It may be manufactured from spelter or zinc oxide, but in the United States it is now generally made from zinc skimmings, ashes, and scrap.

The zinc content of the various pigments made in the United States from ore, both domestic and foreign, for the period 1908–1914, is given in the table below. The figures as heretofore given for each year included the zinc content of zinc dust produced that year. The publication of the production of zinc dust in another table makes it possible to exclude the zinc dust from the quantities below leaving zinc in pigments only.

Zinc content of zinc pigments made in the United States, 1908–1914.

	Short tons.		Short tons.
1908	48,004	1912	64,032
1909	54,139	1913	70,622
1910	50,592	1914	70,619
1911	46,122		

For further details of the production of zinc pigments the reader is referred to the chapter on mineral paints in Part II of Mineral Resources for 1914.

SECONDARY ZINC.

In the ordinary method of galvanizing, where the material to be coated is dipped into a bath of molten zinc, there is great loss of zinc in the form of semioxidized skimmings and of hard zinc drosses, caused by the alloy formed by the zinc with the iron of the tank and of the article being galvanized. In the larger galvanizing plants there are furnaces to refine these skimmings and drosses and to recover the spelter. There are also many small plants and some large ones which make a practice of buying galvanizer's skimmings and drosses and of recovering the spelter. A considerable quantity of old metal in the form of various alloys of zinc with copper and other metals is also worked over and brought up to the desired composition by the addition of new metal. At almost every brass foundry and machine shop in the country it is the custom to remelt and use brass filings, grindings, and scrap copper and brass, and it is manifestly impracticable to attempt to take full account of such material. Some of the zinc smelters running on ore find it advantageous to work in a quantity of secondary material, because the loss of zinc in distillation is practically a fixed quantity per charge, whether the charge be of low or high tenor. If secondary material high in zinc is mixed with low-grade ore, the loss per unit of metal recovered is thereby greatly lessened. Where this is done the smelters make proper returns to the United States Geological Survey, and account has been taken of such production in these reports prior to 1907 as dross or secondary spelter. As such spelter has been recovered by redistillation, it is practically indistinguishable in quality from spelter of ordinary grades made from ore. Several secondary smelters recovering zinc from

drosses do so by redistillation, and these plants are included in the list of smelters on a later page. It has seemed advisable that the secondary spelter recovered by redistillation should be separated from that recovered by remelting, and it has accordingly been done in the table below.

Since 1907 statistics have been collected from the secondary smelters and refineries, for the years 1907 and 1908 by the writer and since 1908 by J. P. Dunlop, of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged, since which time the number of firms has been increased from about 40 to more than double that number, with a large increase in reported production. The following table gives the production of secondary zinc in the United States and a later table gives the production of secondary spelter in Europe:

Production of secondary zinc in 1909–1914, in short tons.

	1909	1910	1911	1912	1913	1914
Secondary spelter, redistilled	9,273	12,784	14,043	26,064	25,991	20,545
Secondary spelter, remelted	23,767	28,439	26,470	26,187	24,014	22,424
Recovered zinc in alloys, excluding old brass remelted	1,181	2,709	3,223	3,912	3,743	3,914
Recovered zinc in remelted brass	8,204	18,450	24,110	28,426	25,822	24,759
Secondary zinc recovered as metal	42,425	62,382	67,846	84,589	79,570	71,642
Secondary zinc recovered in pigment	2,154	2,646	3,036	4,619	3,705	6,536
Secondary zinc recovered in zinc chloride[a]	3,839	3,970	3,865	4,903	6,253	6,429
Total secondary zinc	48,418	68,998	74,747	94,111	89,528	84,607

[a] These figures include only the quantity of zinc chloride used in wood preservation and were furnished by courtesy of the Forest Service, Department of Agriculture.

The output of secondary spelter, both redistilled and remelted, fell off considerably in 1914 and there was also somewhat less zinc recovered in remelted brass than in 1913. The use of skimmings and drosses in the manufacture of zinc pigments and lithopone increased greatly, the zinc content of such pigments being 6,536 tons in 1914 as compared with 3,705 tons in 1913 and 4,619 tons in 1912. The zinc content of zinc chloride made from secondary zinc materials and used in the treatment of railroad ties, bridge and other timbers, as reported by the Forest Service, was 6,429 tons in 1914 as against 6,253 tons in 1913.

The exports of zinc dross, which had nearly stopped in 1913, having gone down from 15,887 in 1906 to 28 tons in 1913, rose again under the stimulus of European prices to 2,526 tons in 1914.

COMPARISON OF TOTALS, BASED ON SMELTER AND MINE REPORTS.

The foregoing figures of the production of spelter by the respective States are compiled from reports from individual zinc smelters. Since 1904 statistics of the production of the more valuable metals in the Western States have been obtained by the United States Geological Survey from reports of individual mines, and since 1907 this compilation has been extended over the whole country. In

order to put the smelter production on the same basis as the mine figures, all the zinc which is manufactured into pigment directly from ore (excluding the quantity in zinc oxide manufactured from spelter, the inclusion of which would entail its duplication in the totals) is added to the production of metallic zinc. The zinc dust recovered during the year is also included here. The zinc recovered from secondary sources is excluded, since it has already been once reckoned as spelter. These facts must be borne in mind in comparing this table with the table showing the production of spelter. The totals obtained by each method for the last eight years are compared in the following table:

Comparison of totals of production of zinc, 1907–1914, compiled from smelter and mines reports, in short tons.

	Totals compiled from smelter reports.	Totals compiled from mine reports.	Smelter excess.	Mine excess.
1907	280,676	259,951	20,725	.....
1908	238,030	234,526	3,504	.....
1909	283,173	305,423	.....	22,250
1910	303,139	327,712	.....	24,573
1911	315,029	345,260	.....	30,231
1912	386,783	378,816	7,967	.....
1913	408,289	406,416	1,873	.....
1914	424,672	406,959	17,713	.....
Total	2,639,791	2,665,063	.....	25,272

The smelter totals represent actual recovery and are found by summing up the total production reported by all companies, all pigments and zinc dust being calculated back to equivalent metallic zinc on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual quantity of zinc ores and concentrates shipped, and from this the zinc content is reckoned by assay value. From that zinc content 10 to 20 per cent, according to the character of the ore, is deducted for smelting losses, and the remainders thus obtained from all the producing properties in each State are combined to afford the totals for the respective States. Where the ore is concentrated at a custom mill, proper allowance is also made for the loss of metal in the process. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from each producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content and the theoretical recovery be correctly estimated. The totals, as compiled from smelter reports and from mine reports, respectively, should be in reasonable agreement. As a matter of fact, for any year they show considerable divergence. These discrepancies, giving rise to "smelter excess" or "mine excess" may be the result of one cause or of a combination of causes, among which are: Lag in the smelting of the ore, resulting in accumulation of ore stocks at the smelters; lag in the mining, owing to which the smelter depletes its ore stocks; error in calculating metallic content from assay and in estimating recovery.

The recoverable zinc content of domestic zinc ore exported from this country since 1907, inclusive, should be added to the smelter totals to

make the comparison complete. According to the figures of the Bureau of Foreign and Domestic Commerce the exports of domestic zinc ore from 1907 to 1914, inclusive, amounted to 149,079 short tons, of which the recoverable zinc content may be estimated at 62,613 tons. If this quantity be added to the smelter total, that total will exceed the mine total, giving a smelter excess of 37,341 tons, or a little less than 1 per cent.

Theoretically the smelter and mine totals taken for a considerable number of years as above should agree closely, as the mine totals express recoverable zinc content of ores, allowance having been made for smelting losses. Difference in smelter stocks of ore at the beginning of 1907 and the close of 1914 would cause a discrepancy in the totals. There were big smelter excesses in both 1907 and 1914, hence there were large stocks of ore at the beginning of 1907 and presumably depleted stocks of ore at the close of 1914. This difference would augment the smelter excess.

An average mine excess for 1915 (and there will in all probability be a mine excess owing to extraordinary activity in zinc mining during the year) would just about balance the smelter and mine totals, indicating that both smelter and mine returns are very accurate, as is also the allowance for loss in zinc smelting.

The smelter reports give the exact annual production of zinc and serve as a check on the mine production, and they also give the form in which the zinc was recovered, whether as spelter or as pigment. For more exact distribution of zinc production according to origin, recourse must be had to the reports of production by mines.

RESOURCES.

GENERAL.

The war has for the time being eliminated certain sources of zinc supply, and, through resulting high prices, has opened other sources. The main dependence of the world for zinc, outside of the Germanic allies, is, of course, the United States. But several other countries find in present conditions a stimulus to activity in production of zinc, among them, Mexico, Canada, Great Britain, Spain, Italy (Sardinia), Africa (Rhodesia), Russia (Siberia), India, Japan, and Australia (New South Wales).

UNITED STATES.

For several years there has been given at this point in this report a table showing for each zinc-producing State the total quantity of zinc-bearing ores produced, and the output of each kind of zinc-bearing ore, as well as the zinc content. This table will hereafter be found in the chapter of Mineral Resources entitled "Metals and ores."

There has also been given here a very brief summary of the zinc-mining operations in each zinc-producing State. This review will hereafter be discontinued, as the data are given in greater detail in the various mine reports by States, and in its stead there is given the following table showing the annual mine production of zinc by States for the period 1907–1914. Statistics of mine production of

zinc are not available for all the States before 1907. These figures of mine production are obtained for the mine reports by the mine operators and not from the smelters, as explained on a previous page.

Mine production of zinc by States, 1907–1914, in short tons.

	1907	1908	1909	1910	1911	1912	1913	1914
Arizona	114	339	2,989	2,742	2,281	4,379	4,714	4,896
Arkansas	474	605	510	994	664	748	478	608
California	116	.....	.....	.....	1,404	2,173	529	195
Colorado	26,394	15,065	25,605	38,545	47,304	66,111	59,673	48,387
Idaho	3,493	19	676	2,802	4,170	6,953	11,587	21,006
Illinois	737	1,717	2,163	3,549	4,219	4,065	2,236	4,811
Iowa	145	395	35	96	.....	.....	.....	.....
Kansas	17,772	14,119	11,445	13,229	10,272	10,633	10,088	11,284
Kentucky	.....	.....	56	6	158	491	327	230
Missouri	116,752	107,404	130,162	128,589	122,515	136,551	124,963	105,994
Montana	122	820	4,680	15,819	21,905	13,459	44,337	55,790
Nevada	1,084	558	1,507	1,354	1,774	6,661	7,210	6,490
New Hampshire	.....	.....	.....	.....	.....	.....	15	6
New Jersey	69,369	67,165	82,510	68,678	77,445	69,755	72,156	74,253
New Mexico	375	1,788	6,543	9,044	5,119	6,783	8,262	9,202
North Carolina	.....	.....	.....	.....	.....	142	10	.....
Oklahoma	1,657	4,529	7,806	6,394	5,150	5,769	11,664	13,992
Tennessee	109	344	596	966	1,117	2,191	5,583	10,425
Texas	22	18	.....	.....	.....	119	326	108
Utah	2,726	730	4,930	8,184	8,920	8,534	9,429	7,995
Virginia	.....	705	58	794	[a] 1,113	249	2,719	174
Washington	.....	.....	.....	.....	10	.....	.....	.....
Wisconsin	18,490	18,206	23,152	25,927	29,720	33,050	30,110	31,113
Total	259,951	234,526	305,423	327,712	345,260	378,816	406,416	406,959

[a] Includes a small quantity of zinc from New York.

MEXICO.

Deposits of zinc are found in the Mexican States of Tamaulipas, Nuevo Leon, San Luis Potosi, Coahuila, and Chihuahua, but most of the zinc ore imported into the United States has come from the two last mentioned.

Statistics of imports of zinc ore from Mexico based upon "consular invoice" or "declaration" are available as far back as 1904, as given on a later page. According to these returns, the imports from Mexico in 1914 continued, owing to the civil conflict in that country, to be much less than normal, being 20,705 short tons containing 7,663 tons of zinc, as compared with 18,018 tons containing 6,377 tons of zinc in 1913, 35,925 tons containing 14,206 tons of zinc in 1912, and 67,818 tons containing 23,517 tons of zinc in 1910. Imports of zinc ore from Mexico during the first six months of 1915 were considerably larger than for the whole of 1914.

CANADA.

The imports of zinc ore from Canada were 11,250 short tons in 1914, as compared with 8,357 tons in 1913.

The zinc ore produced in British Columbia now finds its way to the zinc smelters of the United States, but this seems destined to change in the near future. In the past the output of these ores has not been great, but there is no doubt of their extensive occurrence, and with commercial success in the efforts at reduction, the region must become an important zinc producer.

Strong endeavors have been made by the Dominion of Canada to develop a commercially successful method of reducing the complex

zinc ores of the Kootenay district of British Columbia. The Dominion Government appropriated $50,000 for experimental work, completed in the laboratories of McGill University at Montreal by Dr. Alfred Stansfield, and with further experiments on a larger scale at the electrothermic zinc smelter at Nelson, British Columbia, with what success is related by Dr. Stansfield:[1]

Owing to the long freight haul, United States duties, and other drawbacks, those sales have not been very profitable, and several attempts have been made to smelt the ores in Canada. In the year 1904 a zinc smelter was erected at Frank, Alberta, but proved unsatisfactory and was abandoned, largely because the majority of Canadian zinc ores were unsuitable for treatment by the standard method of smelting. The amount of zinc concentrate that was shipped to the United States is only a small part of the ore that would be available if suitable methods for its treatment were developed, and Canadian ores should furnish enough for the normal Canadian requirement.

The electric smelting of zinc appeared, for a time, to offer a means for the treatment of the British Columbia ores, and experiments were made at Nelson in 1908 by F. K. Snyder and at McGill University in 1910 and Nelson in 1913 by the Department of Mines. Owing mainly to a serious difficulty in regard to the condensation of zinc in the electric furnace, none of these experiments has led to commercial operation. In the meantime experimenters had been looking into the possibility of leaching and electrolytic methods for treating the British Columbia ores. The methods employed here can not be considered as new except in points of detail; they have been tried many times before and have in general been found unsuitable for commercial use. With the inducement of the present high prices of spelter, the problem was taken up with renewed energy and technical success obtained; while arrangements have now been completed with the British war office, the Dominion Government, and the shell committee that will enable the manufacturers to proceed with the production of spelter on a commercial scale. The methods employed by different metallurgists differ in detail, but the process consists generally in roasting the ore, thus forming oxide and sulphate of zinc, which are extracted with the aid of sulphuric acid and water. The zinc sulphate solution is electrolyzed, using insoluble anodes and sheet metal cathodes. The zinc is deposited in a metallic layer on the cathodes, and sulphuric acid is liberated and is used for the treatment of fresh lots of ore. When, as is usually the case, the ore contains lead as well as zinc, the lead remains in the ore residue, and can be smelted in the usual way.

In making brass for cartridge cases very pure zinc must be used, the ordinary brands of spelter not being pure enough. The British Columbia ores contain so much lead that if they were smelted by the ordinary methods the resulting spelter would be far too impure for use in ammunition making, so, for this purpose, the electrolytic method can alone be used. The need of a specially pure spelter for the manufacture of ammunition constitutes an important reason for using electrolytic methods instead of the standard process of zinc smeltings, or even the electric furnace method, for the treatment of the British Columbia ores.

Among the companies now engaged in the production of zinc in Canada by electrolytic methods may be mentioned the Consolidated Mining & Smelting Co., at Trail; the Standard Silver Lead Mining Co., near Silverton, using the French process; and the Weedon Mining Co., using the Watts process in a new plant at Welland.

To encourage the starting of zinc-reduction plants at the present time and to protect them until they are thoroughly established after the conclusion of the war has restored normal conditions in the zinc industry, the Dominion of Canada has granted a small bounty on spelter reduced in Canada from Canadian ores, when the price of the metal falls below a certain point. Further details of the bounty are given on a later page.

GREAT BRITAIN.

Great Britain ordinarily reports about 150,000 short tons of spelter, and in 1913 smelted 65,197 tons. Figures for 1914 are not available, but it is reported that there was a falling off in output notwithstand-

[1] Stansfield, Alfred, Zinc in Canada: Canadian Min. Inst. Bull. 41, pp. 647–649, 1915.

ing the high price and the great demand for spelter. Great Britain had 9 plants suitable for reducing zinc ores. A list of these is given on page 895. Much of the concentrate treated comes from Australia and carries 6 to 8 per cent of lead. Spelter made from such concentrate, mixed with galvanizer's skimmings and drosses, would be of very ordinary grade and could serve for munitions only after refining, which would materially reduce the output. Brunner, Mond & Co., at Northwich, have for many years successfully made spelter by the Hoepfner electrolytic process. The process, worked as one in a series of operations in their chemical works, waste calcium chloride being used instead of salt as a source of chlorine, produces 99.9 per cent pure spelter, which commands a premium on account of its purity, and yields as by-products chlorine gas and calcium carbonate in a form desired by paper makers. The output of these works naturally must be at a maximum at this time.

The dependence of England upon continental Europe for spelter and the dependence of Australia upon continental Europe for a market for zinc concentrates has been a source of much embarrassment since the war began and has evoked many proposals looking toward the establishment of large zinc smelting plants in England to treat the zinc concentrates of Australia. Nothing of the sort has materialized, however, due probably in part to the financial situation and in part to the fear that the price of spelter after the war may slump to a point unprofitable to the insular smelters. To relieve the latter condition, a bounty and a protective tariff have both been proposed.

SPAIN.

The following notes on the zinc resources of Spain are given by Ahlburg: [1]

Calamine is the chief zinc ore, though blende has been found in large quantity in the southeastern metalliferous belt, including Cartagena, Mazarron, and the Sierra Almagrega. The neighborhood of Cartagena at one time furnished a large output of calamine, and the workings round Almeria still yield a certain quantity. In the Province of Teruel, at Linares, a deposit of calamine attaining a maximum thickness of 42½ feet is worked in Mesozoic limestones, but by far the most important center of the Spanish production of zinc ore is the Province of Santander. The largest deposits here occur in the great Carboniferous limestone range of the Cordillera Cantabrica. Over an area of 6¼ miles in length and 1½ miles in breadth calamine is found in "nests" in the limestone, which is extensively dolomitized in the vicinity of the ore. The latter is very pure, and with it are associated, but in small proportion, lead and copper ores and some rare streaks of cinnabar. In depth, undecomposed zinc blende has been occasionally found. The later group of calamine deposits, extending eastward into the Provinces of Biscay and Guipuzcoa, occur in Mesozoic, more especially Cretaceous limestones. The output has diminished rapidly of late years, but this northwestern region of Spain still accounts for the greater part of the output of zinc of the country.

The output of the zinc mines of Spain is more than equal to the capacity of the two Spanish zinc smelters, at Aviles, on the north coast, and at Penarroya, and the surplus has heretofore been disposed of in other countries. Since the war this market has been restricted considerably, and recently an offer [2] was made to contract for the sale of 25,000 tons of Spanish zinc concentrates annually in the United States. Quin's Metal Bulletin is authorty for the statement that the

[1] Ahlburg, Dr. J., Die nutzbaren Mineralien Spaniens und Portugals; Zeitschr. prakt. Geologie, vol. 15, pp. 183–210, 1907. Abstracted in Am. Inst. Min. Eng. Trans., vol. 36, pp. 734–738, 1909.

[2] Ruhl, Otto, The future of the American zinc industry: Min. and Eng. World, vol. 43, pp. 606–609, 1915.

exports of spelter from Spain were 2,843 tons for the first eight months of 1915 as compared with 1,454 tons for the corresponding period in 1914.

ITALY (SARDINIA).

The Sardinian lead deposits were known and worked by the Romans and it is said that the lead for the water pipes of ancient Rome and Pompeii was derived from these mines. Prior to 1865 the calamine encountered in mining for lead was discarded in the dumps. Since that time the zinc ores have been mined and for the last 10 years have been more important in value than the lead ores. The production of calamine ore was 92,000 tons in 1870 and this gradually increased to 127,000 tons in 1900, since which time the annual output has ranged between 100,000 and 130,000 tons.

The calamine mines are situated for the most part in the Iglesias mining district,[1] which occupies a mountainous area in the southeastern part of the island. The deposits of lead and zinc are chiefly in the hands of two companies, the Società di Monteponi, working by open pit the enormous body of oxidized zinc known as the Cungiaus mine and the lead vein deposits near by, and the Società di Pertusola, controlling some four groups of mines, some of the groups covering from 4 to 5 square miles of territory and consisting of oxidized ores of zinc in limestone or of vein deposits of galena and sphalerite in granite and schist. Each company has a lead smelter, the one at Monteponi in connection with the mining and concentrating plants, and the other at Pertusola, near Spezia, in Italy. Neither company has a zinc smelter, and the zinc ores have usually been marketed in Germany or Belgium. The war having closed that market, arrangements were made to dispose of the ores in the United States, with the result that Sardinian zinc ores began to enter this market about the middle of 1915.

AFRICA (RHODESIA).

The Rhodesia Broken Hill ore body consists of a large deposit of oxidized zinc-lead ore in northwestern Rhodesia, according to a report in the Mining Magazine. Great quantities of ore are in sight at the surface. One outcrop is estimated to show 250,000 long tons of ore averaging 26 per cent of lead and 22½ per cent of zinc, and another outcrop is figured at 300,000 long tons averaging 32 per cent zinc with little lead but much iron oxide and carbonate. Great difficulty has been experienced in finding a commercial process to treat the ore, and there has been no output from the mines as yet.

INDIA.

The Bawdwin silver-lead mines of eastern Burma at Lashio, near the Chinese border, are on one of the large ore bodies of the world. They are authentically known to have been worked by the Chinese as far back as 1412 A. D. The Chinese worked the oxidized parts of the ore body principally for the silver, losing the greater part of the lead in the slag, great heaps of which remain to mark the sites of early

[1] Wright, C. W., The lead and zinc mines of Monteponi: Min. Mag., vol. 12, pp. 33–38, 1905; Calamine mines of Sardinia: Eng. and Min. Jour., vol 100, pp. 625–628, 1915.

smelting operations. The Burma Mines (Ltd.) was formed in 1904 to take over these mines and exploit them. Lead is being recovered from the old slag dumps while development work is proceeding in the mines. In August, 1915, the proved and probable reserves of sulphide ores were estimated at 2,000,000 tons having an average assay of 25 ounces silver, 27 per cent lead, and 22.5 per cent zinc. A 6,000-foot tunnel will be completed in the latter part of 1916 when the mines will be able to supply 1,000 tons of ore per day, or over 60,000 tons of recoverable zinc per year. Pending the provision of smelting facilities for the zinc, the mixed lead-zinc ores were being sold to European smelters before the war. These ores have not yet been offered in the United States, and it would be necessary to separate the lead and zinc before they were available for American uses except at plants lying far interior. It has recently been reported that the Swansea Vale zinc smelting works at Llansamlet, Wales, have been taken over by interests associated with the Burma Mines (Ltd.), and will be largely increased in capacity to handle the output of the Bawdwin mines.

RUSSIA (SIBERIA).

Deposits of zinc have long been known in Siberia and some of them have been developed to the point of production. In 1907 there were shipped 1,116 short tons of zinc ore and 9,072 tons in 1908 from the mines in the Ussurisk district. In 1909 it was reported that the Tyuticha mine near Olga Bay, 200 miles northeast of Vladivostok, had shipped 36,000 tons of zinc ore to Germany. The ore body consists of a large deposit of calamine, known to contain at least 200,000 tons,[1] averaging 48 per cent zinc. There are in this vicinity several other mines of which not much more is known than the location. In 1913 there was imported into the United States from Siberia 1,792 short tons of zinc ore, containing 1,397 tons of zinc, which possibly came from the mine just mentioned. It is noted below that arrangements have been made for shipping zinc ores from mines in Siberia convenient to Japan to that country by the Mitsui Mining Co., of Japan.

The Ridder mine, of the Irtysh Corporation (Ltd.), in the Semipalatinsk district of southwestern Siberia, has been recently described.[2] The mine is about 50 miles east of Irtysh River, and about 750 miles upstream from Omsk, on the Trans-Siberian Railway. It is represented as one of the world's most important mineral developments of recent years. It was formerly worked for its oxidized ores, but the present objective is a large body of sulphide ores beneath the old workings. The exploration work by H. H. Knox yields an estimate of 883,000 tons of solid sulphide ore averaging 31 per cent zinc and 2,448,000 tons of disseminated ore averaging 5.6 per cent zinc. Zinc and lead smelting plants are being constructed adjacent to the Ekibastus coal fields on the river about midway between the mines and Omsk. It is reported that the zinc smelter will start in April, 1916, with a capacity of 4,000 tons of spelter.

[1] Purington, C. W., The Tyuticha zinc mine: Min. and Sci. Press, vol. 99, p. 200, 1909.
[2] Eng. and Min. Jour., vol. 99, pp. 599–603, 1915; from H. H. Knox's report to the company.

JAPAN.

Japan has within a few years become a producer of zinc ores and more recently has begun to produce spelter. The following extract from a pamphlet on the mining industry of Japan, issued by the Japanese Bureau of Mines, is from the pen of T. Hirabayashi, the quantities and values being reduced to short tons and dollars:

The mining of zinc ore was first introduced in 1905, and the production is increasing annually. In 1913 it amounted to 38,223 short tons, valued at $426,875. The ore is produced in Honshu and Kyushu, as shown by the following figures:

District.	Quantity.	Value.
	Short tons.	
Honshu	34,776	$39,895
Kyushu	3,447	24,934

The zinc ore is almost entirely exported. In 1913 the amount exported was 30,148 short tons, the customs valuation of which is put at $469,749. Up to very recent times no attempt had been made to set up plants for smelting zinc, and large quantities of this metal was imported annually in forms of slabs, blocks, ingots, sheets, etc., from Germany, England, and Belgium. But two smelters have lately begun their work, and it is now expected that their output will be sufficient to supply our demand for spelter.

Zinc blende is the most common ore of zinc and is usually associated with galena and chalcopyrite. Very rarely calamine and smithsonite are found in the oxidized zone. There are three kinds of deposits, viz: (1) Fissure veins, (2) metasomatic deposits, and (3) contact-metamorphic deposits. All of them are equally frequent, but most of the present producers belong to the second type.

The Kamioka mine, situated about 45 miles south of Toyama city, is the largest zinc producer at present. The ore occurs there in deposits of the contact-metamorphic type lying between quartz porphyry and gneiss. The mining claim is about 3,800 acres, in which not a few deposits, each forming a tolerably large mass, have been found. The raw ore contains 0.01062 per cent Ag, 4.82 per cent Pb, and 12.50 per cent Zn on an average. After the separation of blende from galena, the tailings are treated by flotation process. At present about 2,000 tons of dressed ore containing more than 45 per cent Zn are monthly produced.

For the following data on the zinc-smelting industry of Japan the Survey is chiefly indebted to T. Hirabayashi, of the Japanese Bureau of Mines, and J. Kojimi, of the Ashio Copper Co.

The Osaka-Ayen Co. operates the largest zinc smelter in Japan. It uses retorts of the usual type, has a capacity of 6,000 tons of spelter per year, and is located at Konoshima on a small island in the inland sea between Honshu and Shikoku. It is being enlarged to two or three times its present capacity. The company owns two small mines, but depends almost altogether on custom ores.

The Mitsui Mining Co. has a zinc smelter of modern German design utilizing waste heat from coke ovens at the Miike colliery in the Fukuoka district. It has a capacity at present of 3,000 tons per year, but will be enlarged to five or six times that capacity. The Mitsui Mining Co. has large zinc mines and smelts its own ores for the most part, but has lately made arrangements with owners of Siberian zinc mines for additional ore to supply the enlarged plant.

The Niphon Ayen Co. three years ago established an electrolytic zinc plant in the Niigata district. It is operated by hydroelectric power and has a capacity of about 600 tons per year.

The Fujita Co., operating the Kosaka zinc mine in the Akita district, has likewise for a couple of years been making spelter by an electrolytic process. The capacity of the plant, which is also run by hydroelectric power, is about 250 tons per year.

According to the Engineering and Mining Journal, the output of spelter from Japanese smelters in 1914 was 5,236 short tons, of which the Osaka-Ayen Co. produced 1,984 tons and the Mitsui Mining Co. 3,252 tons. The imports of zinc in the form of both spelter and zinc sheets amounted to 6,400 short tons, as against 12,000 tons in 1913. The domestic needs and the consumption of spelter in the manufacture of munitions for the allies by Japan being taken into consideration, it does not seem probable that any spelter will be available from Japan until after the war.

The electrolytic smelters were largely experimental and have been operated irregularly. The spelter produced is very pure, but is very expensive and can not ordinarily be sold in competition with other commercial spelter. The whole product has heretofore been sold to the Japanese Navy Department. The demand for high-grade spelter for munitions will no doubt cause the electrolytic plants to be run to full capacity during the present year.

Up to a year ago none of the zinc smelters in Japan paid a profit on their operations.

AUSTRALIA (NEW SOUTH WALES).

The principal source of zinc in Australia is the silver-lead mines of Broken Hill, New South Wales. In the early days of Broken Hill mining the crude ore ran about 25 per cent each in lead and zinc and 25 ounces in silver, but by 1904 the average tenor had become reduced to 16 per cent each of lead and zinc, with 11 ounces of silver to the ton. At present the average tenor is probably somewhat below those figures. In the effort to get rid of the zinc it was heaped up in enormous piles of zinc tailings and slimes from the concentrating plants, and lead concentrates with 20 per cent of zinc were smelted, lead slags averaging 16 per cent of zinc oxide with a maximum of 20 per cent having been run, according to Donald Clark.[1] Various leaching, electrolytic, and magnetic processes were successively tried and finally discarded for the flotation processes which have been in practical use since 1903. This method of concentration has the advantage that it can be applied to the current output of zinc tailings and slimes as well as to the accumulated stocks of those products.

The importance of flotation in that country is shown in the following table of the production of zinc concentrates at Broken Hill by flotation methods for the period 1912–1914, compiled from the annual reports of the department of mines of New South Wales. These concentrates are recovered from zinc middlings and tailings, both from the current product and from the stored accumulations of bygone years of milling operations. The minor quantities of lead concentrates recovered, as a table product from the zinc concentrates, are not included.

[1] Clark, Donald, Australian mining and metallurgy, Melbourne, 1904, p. 372.

Production of zinc concentrates at Broken Hill, New South Wales, 1912–1914, in long tons.

Company.	Flotation process used.	1912		1913		1914	
		Tailings treated.	Concentrates.	Tailings treated.	Concentrates.	Tailings treated.	Concentrates.
Sulphide Corporation	Minerals separation.	.....	71,040	174,287	63,446	152,146	52,059
Broken Hill Proprietary	Potter-Delprat.	316,441	88,008	349,290	85,685	246,682	53,596
Amalgamated Zinc (De Bavay's).	De Bavay.	538,086	147,013	498,289	140,098	412,823	115,204
Zinc Corporation	Minerals separation.	345,425	85,354	350,120	86,230	221,620	48,325
Do	Horwood	.....	.....	.....	.....	.....	3,986
British Broken Hill	Minerals separation.	.....	27,298	26,754	6,356	.....	(a)
Junction North	.....	.....	.....	68,426	16,944	.....	(a)
Total concentrates produced.	.....	.....	418,713	.....	398,759	.....	273,170
Average zinc content, per cent.	.....	.....	47.2	.....	47.0	.....	47.1

a Treated by Zinc Corporation.

The subjoined table compiled from the annual reports of the department of mines of New South Wales shows the quantity and zinc content of zinc concentrates exported from New South Wales from 1904 to 1914.

Exports of zinc (spelter and concentrates) from New South Wales, 1904–1914, in short tons.

Year.	Concentrates.	Zinc content.	Year.	Concentrates.	Zinc content.
1904	64,514	24,996	1910	524,862	207,085
1905	115,956	34,313	1911	578,343	213,321
1906	114,984	37,438	1912	582,980	217,520
1907	264,601	85,842	1913	567,482	206,247
1908	309,044	127,515	1914	402,427	163,968
1909	418,775	161,300			

Further details as to present stocks of tailings and current and future output, will be found in the chapter on zinc in Mineral Resources for 1913, Part I, pages 636–638.

The zinc smelter of the Broken Hill Proprietary Co. (Ltd.), at Port Pirie, now has seven distillation furnaces, with one additional building. It is planned to add more furnaces gradually until the output is brought up to about 25,000 tons per year. A spelter refining plant and a zinc rolling mill are also contemplated. The output of the plant in 1914 was 5,616 short tons.

METALLURGY.

CONCENTRATION.

PROGRESS OF FLOTATION CONCENTRATION.

A brief description of several ore flotation processes was given in Part I of Mineral Resources for 1908 (pp. 251-256). Since that time, however, various improvements have been made in the different processes, and new processes have been invented. These were reviewed in Part I of Mineral Resources for 1913 (pp. 639-642). Nothing further calls for mention at this point except to chronicle the great expansion in the use of ore flotation in the treatment of copper sulphide, lead sulphide, zinc sulphide, and mixed sulphide ores in the United States.

The successful use of flotation has made a great zinc-producing district of the Butte (Mont.) region, is making an important zinc district out of the Coeur d'Alene region, and is increasing the production of zinc in Utah and Colorado. The United States Bureau of Mines, the Missouri Bureau of Geology and Mines, and the University of Kansas are making observations and tests bearing on the susceptibility to ore flotation of the zinc and lead ores of the Joplin district. The mill recovery from these Joplin ores in the form of 58 per cent zinc concentrates averages, according to Wright,[1] from 60 to 65 per cent of the zinc content of the crude ore. The larger losses are in the slimes and the "chats," the local term for small particles of ore partly surrounded by siliceous gangue. The "chatty ores" consist of ore very finely disseminated through the siliceous gangue. The fine grinding necessary to free this ore would greatly increase the slimes, reduce the capacity, and necessitate much increase in machinery to handle the slimes.

Joplin practice, growing out of the short-lived individual deposits, has been to sacrifice high recovery to capacity and cheapness. The results of the experiments by the University of Kansas have been published in brief.[2] Pine oil under the conditions of the laboratory test yielded a froth concentrate assaying 53 per cent of zinc, with a recovery of 73 per cent of the zinc content of the slime. If the mill recovery of zinc in the Joplin district, averaging nearly 150,000 tons metallic zinc for the last four years, could be raised from an average of 60 to 65 per cent to an average of 70 or 75 per cent (the recovery by flotation at Butte is probably about 95 per cent), it would add 25,000 tons of metallic zinc to the output of the district. Moreover the increased saving would make deposits workable which were too lean to mine profitably before and thus further increase the output of the district.

The American Zinc Co. of Tennessee, at Mascot, Tenn., by adding a flotation plant and otherwise enlarging the concentrating plant has increased its capacity to over 2,000 tons daily.

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[1] Wright, C. A., The mining and treatment of lead and zinc ores in the Joplin district, Mo.; a preliminary report: U. S. Bur. Mines Tech. Paper 41, pp. 43, 1913.

[2] Belchic, George, and Allen, G. L., Flotation of Joplin-Galena slime: Metall. and Chem. Eng., vol. 13, p. 847, 1915.

Space is not available here to describe in detail the installations of the various systems, but a most interesting and complete chapter on the flotation concentration of ores is to be found in Mineral Industry for 1914 (pp. 855-866), which outlines the historical development of flotation methods, states the principles involved, and gives a list of the installations in the United States up to the close of 1914. The statement is made that a billion tons of ore of various kinds was treated by flotation in 1914, which quantity will probably be greatly exceeded in 1915.

Litigation regarding patent rights to the basic process of ore flotation initiated by the Minerals Separation Co. against James H. Hyde and the Butte & Superior Co., and decided in favor of the plaintiff by the United States Circuit Court of Appeals at San Francisco, May 4, 1914, has been appealed to the Supreme Court of the United States.

REDUCTION.

GENERAL STATEMENT.

The prevailing high price of zinc has greatly stimulated experimentation in wet methods of reduction of zinc ore, either in purely chemical ways or, more especially, by combinations of chemical and electrolytic methods. The prospects are that a practical electrolytic method will be evolved, as any process will be relieved by the present high prices from the ordinary discouraging unremunerative, trying-out period; and commercial success may have been attained by the time spelter drops back to normal prices.

CHEMICAL REDUCTION.

The high zinc content of the copper ores of the eastern part of the Shasta County copper district of California has caused much trouble in smelting in the blast furnace so that some plants have shut down and others have installed bag houses to filter out the zinc "fumes," which are accumulating in large quantities with no present available use. At the Afterthought mine, S. E. Bretherton [1] has developed a leaching process which he summarizes as follows:

> Grind the ore, roast, regrind, leach out zinc with ammonia and carbon dioxide, precipitate from the solution any copper which has been dissolved with the zinc, and put back in the residue. Smelt the residue for the recovery of copper or lead, with the gold and silver. The ammonia and excess carbon dioxide are distilled from the solution containing the zinc and recovered for further use. As the ammonia is being distilled, the zinc is precipitated as a pure white basic zinc carbonate, filtered out, and then calcined to zinc oxide, or the basic zinc carbonate can be reduced direct to either zinc chloride or spelter.

The testing plant is of laboratory size, with a capacity of 150 pounds of ore, but it has been in operation for two years and is reported to have yielded satisfactory results. In a test run in February and March, 1914, the zinc extraction varied from 80 per cent on 18.6 per cent ore to 85 per cent on 21 per cent ore.

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[1] Bretherton, S. E., Preparation of ore containing zinc for the recovery of other metals such as silver, gold, copper, and lead by the elimination and subsequent recovery of the zinc as a chemically pure zinc product: Am. Inst. Min. Eng. Bull. 80, pp. 1481–1487, 1913; also, The treatment of complex ores by the ammonia-carbon dioxide process: Am. Inst. Min. Eng. Bull. 91, pp. 1771–1777, 1914.

The bisulphite process is used in treating complex zinc-lead sulphide ores in Wales, and in treating zincky copper ores at the Rosebury mine in Tasmania. The process is described as follows: [1]

The ore, after pulverization, is roasted in mechanical furnaces, the sulphurous anhydride being conveyed from the roasting furnaces to the extraction towers. The roasting is done very slowly, 24 hours being required to finish a charge.

The roasted ore is conveyed to the top of a specially designed tower, where a weighed amount is mixed with a weighed amount of water, so as to form a thin pulp. This pulp descends through the tower, meeting the sulphurous anhydride gas coming up. The agitation produced by the interior construction of the tower brings about such an intimate and effective contact of the pulp with the sulphurous anhydride that by the time the pulp reaches the receiving tanks at the bottom of the tower nearly 90 per cent of the zinc has been extracted.

The solution of zinc bisulphite is drawn off into an apparatus, wherein it is heated, precipitating zinc monosulphite. The latter is calcined, yielding zinc oxide, which goes to spelter furnaces, the Villiers works having been purchased for smelting it. In that works spelter assaying 99.85 per cent zinc is produced. This spelter is said to fetch about 0.9 cent per pound more than ordinary spelter.

The extraction of zinc in the bisulphite process proper is said to be from 84 to 89 per cent in the case of the better-roasted charges.

ELECTROCHEMICAL REDUCTION.

UNITED STATES.

The Malm process of dry chlorination for complex sulphide ores, dissolving the chlorides, precipitating the other metals by zinc, and recovering the zinc by electrolysis, was described in the chapter on zinc in Part I of Mineral Resources for 1910, page 282. The plant then under construction at Georgetown, Colo., has not yet been operated, but it is reported in the mining press that preparations are being made to start up shortly.

The Northwestern Metals Co. has completed at Helena, Mont., a 100-ton plant, costing $750,000, which uses the Malm dry-chlorination process. Complex sulphide ores are chloridized; the metals are dissolved as chlorides; gold, silver, lead, and copper are precipitated by zinc dust and are recovered by the usual process of lead smelting. The zinc chloride in solution is evaporated and fused, and the zinc is recovered by electrolysis.

The Anaconda Copper Mining Co. is operating an electrolytic zinc plant at Great Falls, Mont., which started in October, 1914, with a capacity of 10 tons daily, but before the beginning of 1916 will have completed an addition, increasing the capacity to 25 tons. No information as to process or results has been given out by the company, but it is reported that the ores are leached with sulphuric acid, and the zinc is electrolytically deposited on aluminum cathodes, stripped, and melted in large kettles. The first spelter made in October was reported to assay 99.9 per cent pure. The Anaconda Co. is putting in shape for operation the Alice mine, once a famous silver mine, which has extensive zinc deposits, and also the Emma and Lexington mines, well-known silver mines temporarily abandoned on account of zinc. The Washoe concentrator and flotation plant is being remodeled and largely increased in capacity.

The Reed Zinc Co. operated an experimental electrolytic zinc plant of semicommercial size at Palo Alto, Cal., during 1914–15. The Reed process,[2] a modification of the Hering process, is used. The

[1] Eng. and Min. Jour., vol. 95, p. 792, 1913.

[2] Leslie, E. H., Electrolytic zinc—the Reed process: Min. and Sci. Press, vol. 110, pp. 17–21, 1915.

zinc is reduced to a solution of zinc sulphate, from which a high extraction is obtained by electrolysis. The aim of the work is to devise a way to treat successfully the zinciferous bag-house product from the mammoth copper smelter at Kennett, of which, as mentioned above, there are large quantities. This dust has a small content of gold, silver, copper, and iron, 8.2 per cent of lead, 6.2 per cent of arsenic, 14.6 per cent of zinc oxide, and 38.6 per cent of zinc sulphate. The dust is digested with a weak solution of sulphuric acid, settled, decanted, the metals other than zinc precipitated by the addition of more dust, again settled, decanted, and filtered, and the solution evaporated until the zinc sulphate crystallizes. The crystallized sulphate is again dissolved in the spent solution from the electric cells, is electrolyzed with the recovery of zinc on the aluminum cathodes and of sulphuric acid on the lead anodes, combining with them to form lead sulphate. With a reversed current these lead-sulphate anodes, transferred to other cells, are reduced again to spongy lead and sulphuric acid, the latter of which commences the circuit again in the digester. The spelter produced averages 99.88 per cent pure, and there is an extraction of 93 per cent of the zinc in the material. Technically the process is successful, but commercially there was, at the close of 1914, a question of costs. With zinc at prevailing prices this question is probably eliminated for the time being.

The River Smelting & Refining Co., affiliated with the National Lead Co., has established experimental plants at Keokuk, Iowa, and Florence, Colo., to work out a process, presumably electrochemical, for the reduction of complex zinc-lead ores.

The Bully Hill Copper Mining Co. has built a small testing electrolytic plant at the mine at Winthrop, Shasta County, Cal., and is endeavoring to ascertain whether the zincky copper ores can be profitably worked by that process.

CANADA.

As noted on page 878, there have recently been three installations in Canada of electrolytic processes to recover zinc. One of these was at the small experimental plant at the Standard Silver Lead Mining Co. near Silverton, British Columbia. Here was installed the French process which has been described by the inventor, as follows:[1]

> The ore is crushed to pass one-twelfth of an inch mesh. Concentrates may be taken as they come from the mill and passed through a calcining furnace until almost sweet, and while still hot and in the furnace about 4 to 5 per cent of bisulphate of sodium, ordinary niter cake, which is a cheap waste product from sulphuric and nitric acid manufacture, is mixed with the charge, and after a few minutes the ore is withdrawn and allowed to cool. It is then transferred to leaching tanks and water slightly acidulated with a little niter cake is allowed to percolate through it. This dissolves all the zinc and manganese and leaves the whole of the lead, silver, iron, etc., in the residue in condition to be sent to the smelters. The zinc and manganese solution, which is very strong, is run into electrolytic tanks, where the former metal is deposited on the cathode plates as clean, pure spelter, and the latter as manganese dioxide on the anode plates. An important part of the process is this perfect separation of the zinc from the manganese. The manganese dioxide has a ready market and fetches a good price.
>
> The bisulphate of sodium used in the calcining and leaching operations is regenerated in the electrolytic tanks and goes round in a cycle, so that very little requires to be bought, and, being a waste article, its first cost is very low.

[1] British Columbia Min. and Eng. Record, May, 1912, p. 299. Quoted from Nelson (British Columbia) News.

Some results of the experiments have been announced in the Canadian Mining Journal of September 15, 1915:

The ore treated was tailing from the concentrating plant, running from 25 to 35 per cent zinc, with small value in silver and lead. The extraction made was 90 per cent of the zinc content. The residue was 45 per cent in weight of the original ore, so that the consequent enriching in silver and lead and the elimination of nearly all the zinc left it of sufficiently high value to be treated at a smelter.

The Consolidated Mining & Smelting Co., at Trail, British Columbia, after successfully operating for six months an electrochemical zinc plant having a capacity of half a ton of spelter per day, is building a commercial plant having a reported capacity of 25 tons of spelter per day, which is expected to be completed before the close of 1915. The ore is roasted, leached with sulphuric acid and electrolyzed, lead anodes and aluminum cathodes being used, and the zinc being stripped from the cathodes, melted, and cast in slabs. The advantages of locating the zinc plant at the lead smelter are apparent when it is considered that the complex lead-zinc sulphide ores of British Columbia form the ore supplies of the lead smelter, which is situated in a region of cheap hydroelectric power that is used already in the electrolytic lead refinery. It is officially announced that the Canadian Government has contracted for the entire output of the new plant.

The Zinc Co. (Ltd.) has built an electrolytic plant at Welland, Ontario. It uses the newly developed Watts process, of which no details are available. It is reported to have a capacity of 10 tons of spelter per day.

OTHER COUNTRIES.

On page 879 mention was made of the electrolytic zinc smelter which has been operated for many years in connection with a chemical works in Great Britain by Brunner, Mond & Co., at Northwich. In discussing the zinc resources of Japan on page 882, note was taken of two small electrolytic zinc plants which have been running for two or three years.

ELECTROTHERMIC ZINC SMELTING.

W. R. Ingalls[1] has briefly summarized the state of progress in electrothermic zinc smelting as follows:

No additional news of technical nature has come from Trolhattan and Sarpsborg. A lawsuit over patents between the Trolhattan and the Ilen companies in Norway was decided in favor of the latter. Thierry is reported to be smelting in the Pyrenees zinc residues from the indigo-dyeing industry and to be making a commercial success of it. Krefting did experimental work in Norway, Côte and Pierron at Ugine in Savoy, and Queneau in Belgium. The experimental work at Nelson, British Columbia, was discontinued, it being regarded as conclusively settled that an electric zinc-smelting furnace so small as 1 ton of daily capacity is a commercial impossibility, while the satisfactory development of a larger furnace was regarded as too doubtful to be undertaken at Nelson. Johnson did a lot of interesting work at Hartford, Conn., and organized a company that is going to build a commercial plant at Keokuk, Iowa, his plans including a 100-ton plant, the first 10-ton unit of which is now being designed.

Some results of trial runs of the Johnson furnace, at Hartford, are given in the chapter on zinc in Part I of Mineral Resources for 1913, page 643.

[1] Ingalls, W. R., The metallurgy of zinc in 1914: Mineral Industry, vol. 23, p. 798, 1915.

ZINC SMELTERS.

The following table gives the zinc-smelting capacity of the United States on December 31, 1914, and June 30, 1915, as well as the retorts under construction or contemplated during the latter half of 1915. Those plants which have an "A" in the column headed "Acid plant" operate sulphuric-acid plants, either at the smelter or elsewhere, as indicated in the footnotes.

Active zinc smelters in the United States, showing capacity in 1914 and 1915, by companies and States.

[Includes plants working on ore alone, on ore and drosses, and on drosses alone.]

State.	Operating company.	Location.	Acid plant.	Retorts at close of 1914.	Retorts June 30, 1915.	Additional retorts contemplated or under construction.
Colorado	United States Zinc Co.	Pueblo		1,920	2,240	320
Illinois	American Zinc Co. of Illinois.	Hillsboro	A	4,000	4,000	
Do.	Collinsville Zinc Smelting Co.	Collinsville		[a] 1,536	1,536	
Do.	Granby Mining & Smelting Co.	East St. Louis	A		1,620	1,620
Do.	Hegeler Zinc Co.	Danville	A	1,800	3,600	
Do.	Illinois Zinc Co.	Peru	A	4,640	4,640	
Do.	Matthiesson & Hegeler Zinc Co.	La Salle	A	5,256	6,168	
Do.	Missouri Zinc Co.	Beckemeyer		192	192	160
Do.	Mineral Point Zinc Co.	Depue	[b] A	9,080	9,068	
Do.	National Zinc Co.	Springfield	[c] A	3,200	3,200	
Do.	Robert Lanyon Zinc & Acid Co.	Hillsboro	A	1,840	1,840	800
Do.	Sandoval Zinc Co.	Sandoval		996		900
				32,540	35,864	3,480
Kansas	American Zinc, Lead & Smelting Co.	Caney		[d] 3,648	4,596	1,524
Do.	do.	Dearing		[d] 3,840	4,480	
Do.	Chanute Spelter Co.	Chanute		[a] 1,280	1,280	
Do.	Cherokee Smelting Co.	Bruce			896	
Do.	Edgar Zinc Co.	Cherryvale		4,800	4,800	
Do.	Granby Mining & Smelting Co.	Neodesha		3,760	3,760	
Do.	Joplin Ore & Spelter Co.	Pittsburgh			1,120	224
Do.	Pittsburg Zinc Co.	do.		[a] 910	896	448
Do.	Prime Western Spelter Co.	Gas	[e] A	4,768	4,868	
Do.	United States Smelting Co.	Altoona		[d] 3,960	3,960	660
Do.	do.	Iola			1,400	2,040
Do.	do.	La Harpe		1,856		1,924
				28,822	32,056	6,820
Missouri	Edgar Zinc Co.	St. Louis		1,100	2,000	
Do.	Nevada Smelting Co.	Nevada				672
Oklahoma	Bartlesville Zinc Co.	Bartlesville		5,184	5,184	
Do.	do.	Collinsville		8,064	8,064	2,016
Do.	Kusa Spelter Co.	Kusa				3,300
Do.	Lanyon-Starr Smelting Co.	Bartlesville		3,456	3,456	
Do.	National Zinc Co.	do.		4,260	4,970	
Do.	Tulsa Fuel & Manufacturing Co.	Collinsville		6,232	6,232	
Do.	United States Zinc Co.	Sand Springs		2,400	4,800	1,600
				29,596	32,706	6,916

[a] Idle in 1914.
[b] The Mineral Point Zinc Co. also operates an acid plant at Mineral Point, Wis.
[c] The National Zinc Co. has zinc-roasting furnaces at Argentine, Kans., where the sulphur gases are utilized in an acid plant, the roasted concentrates being shipped to the smelter at Springfield, Ill.
[d] Practically idle in 1914.
[e] The Prime Western Spelter Co. has roasting furnaces and an acid plant at Tiltonville, Ohio.

Active zinc smelters in the United States, showing capacity in 1914 and 1915, by companies and States—Continued.

State.	Operating company.	Location.	Acid plant.	Retorts at close of 1914.	Retorts June 30, 1915.	Additional retorts contemplated or under construction.
Pennsylvania	American Steel & Wire Co.	Donora	A	.....	.....	9,600
Do	American Zinc & Chemical Co.	Langeloth	A	880	3,648	3,648
Do	New Jersey Zinc Co. (of Pennsylvania).	Palmerton	.....	5,760	6,720	.....
				6,640	10,368	13,248
West Virginia	Clarksburg Zinc Co	Clarksburg	.....	1,824	2,736	912
Do	Grasselli Chemical Co	.....do	[a]A	5,760	5,760	.....
Do	.....do	Meadowbrook	A	6,912	6,912	1,680
				14,496	15,408	2,592
Total for all States				115,114	130,642	34,048
	Plants with special retorts: [b]					
	Michael Hayman & Co.	Buffalo, N. Y.	.....	12	12	.....
	Trenton Smelting & Refining Co.	Trenton, N. J.	.....	40	80	.....
	William Cramp & Sons Ship & Engine Building Co.	Philadelphia, Pa.	.....	24	32	.....

[a] The Grasselli Chemical Co. operates acid plants in connection with its zinc-roasting furnaces at Grasselli, Ind., Cleveland, Canton, and Lockland (near Cincinnati), Ohio, and Newcastle, Pa., the roasted zinc concentrates being shipped to the smelters at Clarksburg and Meadowbrook, W. Va.
[b] Large graphite retorts yielding 600–800 pounds of spelter per charge.

In the foregoing list there are a few smelters which treat only secondary materials, such as zinc ashes, skimmings, and galvanizers' drosses. There are also a few which recover about equal quantities of spelter from ores and from secondary materials, as well as several more which treat minor quantities of secondary materials. There are several other zinc-smelting plants in the country which obtain spelter by distillation of zinc ashes and drosses in large graphite crucibles and condensers somewhat similar to those used in the Faber du Faur furnaces for recovering zinc from the zinc crusts in lead desilverization. These are given at the bottom of the list.

TOTAL SMELTER CAPACITY.

From the 115,114 retorts listed above as in existence at the close of 1914, there should be deducted 20,646 retorts at plants either idle during the year or just completed at the close of the year or engaged in smelting secondary material, which leaves 94,468 retorts as effective for ore at the close of the year. Owing to the low price of spelter which prevailed during the first half of 1914, many plants must have been at part capacity, and the erratic course of the spelter market during the last half of the year must have deterred most of these from speeding up production, so that it was not until well into 1915 that the American spelter industry got into its full stride.

As the total number of retorts was 115,114 at the close of 1914 and 130,642 at the close of June, 1915, there was an increase of 16,728

retorts, or 14 per cent, over the smelting capacity in 1914. The whole number of retorts in operation in June was about 129,000. Since June, 1915, 34,048 retorts have been completed or are under construction or in contemplation. If all these are constructed together with the 3,300 additional at the Kusa smelter, the zinc-smelting capacity of the country will be increased more than 40 per cent over 1914. It seems likely, however, in view of the recent decline in prices of spelter and the large increase in capacity already available that some of the contemplated additions will not be made.

AVERAGE SPELTER CAPACITY PER RETORT.

In 1908 the United States Geological Survey instituted an inquiry to determine the smelting capacity per retort. The result of this inquiry gave 4¼ short tons of spelter as the maximum output per retort with steady operation.

The zinc content of ore smelted ranges from about 20 per cent in some Leadville carbonates to 60 per cent in Joplin blende. The spelter yield per retort does not vary exactly with the zinc content of the charge, for the smelting loss is more or less constant for each charge. Hence, two charges of 30 per cent zinc ore will show double the loss of a charge of 60 per cent ore, or probably more than double, on account of the extra foreign material in the charge.

During the period 1906–1908 about 62 per cent of the spelter smelted in the United States was produced from Joplin high-grade ores. In the last few years only about 40 per cent of the total has been smelted from Joplin ores, and owing to this more extensive use of lower-grade ores the capacity per retort must tend to be somewhat lower than in 1908. Again, owing to the large probable production for the current year, the high-grade Joplin ores will constitute a still smaller proportion of the total than heretofore; hence the average output per retort will be lowered still further. Another fact that tends to reduce the average is that owing to the unprecedented difference in price between "prime western" and high-grade spelter, a considerable number of retorts are employed in redistilling "prime western" spelter to improve its grade, reducing by that much the capacity for smelting ore and hence the average output per retort. These facts are offset to a certain extent by the improvement in zinc recovery which must have taken place since 1908. It is plain, however, that a somewhat exaggerated notion of the possible output of spelter will result from multiplying the number of retorts by 4¼ tons.

For several years the United States Geological Survey has been giving the total number of retorts in existence at the close of the year. From these are subtracted the retorts in idle smelters and the retorts engaged in smelting skimmings and drosses, leaving the effective smelting capacity. The latter, however, may include an unknown number of idle retorts at smelters which are operating at partial capacity. It also counts as active through the year all retorts constructed during the year. Dividing the total quantity of spelter produced in 1910–1914 by the "effective" retorts for that period we have an output per retort of 3.5 tons. The actual capacity per retort can not be less than this, and must be more, owing, as pointed out above, to the

inclusion of idle retorts at operating smelters and of new retorts operating only a portion of the year.

A canvass of the zinc smelters in December, 1913, showed 85,051 retorts in operation. Some retorts were added to those during the year, so that there were 94,468 retorts effective for ore at the close of 1914. If we assume that the addition of new retorts was distributed evenly we have 89,760 retorts as the estimated average number in operation through the year. Dividing the total spelter production, 353,049 tons, by 89,760, the average number of retorts in operation, we obtain 3.9 tons per retort as the average capacity, and this is almost the mean of the results, 4.25 and 3.5 reached above as extremes of retort capacity.

SMELTER CHANGES IN 1914.

There was not much change in the zinc-smelting capacity of the United States during 1914 as compared with 1913. Of two new plants, that of the American Zinc & Chemical Co., at Langeloth, Pa., was ready for operation, in part, with 880 retorts. The plant was designed to have 3,520 retorts when complete. The other new plant was that of the Tulsa Spelter Co., at Sand Springs, Okla., which completed 2,400 retorts by the close of the year, with 1,600 under construction. The Clarksburg Zinc Co., of West Virginia, reported 912 retorts less than in 1913, and the plant of the Nevada Zinc Co. was sold and dismantled. The Mineral Point Zinc Co. added 2,280 retorts, a total of 9,080, the largest retort capacity at any single plant in the country at the end of 1914. The American Zinc Co., of Illinois, added one block of 800 retorts at Hillsboro.

According to the Engineering and Mining Journal the Saeger retort charging machines are installed at the Bartlesville works of the National Zinc Co. These machines charge the retorts in one hour as against three hours required in hand charging, and charge more material per retort. The Simmonds retort-discharging machine was developed at La Harpe and has been used at Iola. Arrangements are now being made to install the machine at three smelters. It is reported to take less than one minute to discharge a vertical row of retorts. Most smelters with acid works use the Hegeler furnace, and most of those not making acid use some form of the long mechanically raked roasters. The Grasselli Chemical Co. has recently adopted the Spirlet, one of the newer forms of multiple hearth furnaces now popular abroad. It is said to be very economical of fuel.

SMELTER CHANGES IN 1915.

The following notes from the midyear spelter statement issued August 26, 1915, are repeated here as a matter of record in this time of rapid change in the industry:

As was natural under the circumstances, there was much activity in smelter building during the first half of the year, with further increases under construction or planned for the immediate future.

In Pennsylvania the American Zinc & Chemical Co. completed the new plant at Langeloth as planned, with 3,648 retorts, and immediately began construction to exactly double the capacity for both spelter and sulphuric acid. The New Jersey Zinc Co. added about 960 retorts at the Palmerton plant. The American Steel &

Wire Co. began the construction of a large plant at Donora, about 25 miles south of Pittsburgh, on Monongahela River. The plant will contain 9,600 retorts, with a planned capacity of 40,000 tons a year of spelter and the equivalent quantity of acid. It is expected that a portion of the plant will be ready for operation at the beginning of 1916. In West Virginia both the Grasselli Chemical Co. and the Clarksburg Zinc Co. made additions.

In Illinois the Granby Mining & Smelting Co. completed the plant at East St. Louis, with 1,620 retorts and an acid plant. An addition which will double the capacity is building. The Hegeler Zinc Co. constructed 1,800 additional retorts at Danville, doubling the capacity of both the smelting plant and the acid plant. The Matthieson & Hegeler Zinc Co. added 912 retorts at La Salle, and the Robert Lanyon Zinc & Acid Co. will add 800 retorts at Hillsboro. The plant of the Sandoval Zinc Co. was destroyed by fire early in the year, but has been rebuilt and is now being operated with about 900 retorts.

In Missouri the Edgar Zinc Co. is operating 2,000 retorts, against 1,100 at the close of 1914. The old smelter at Nevada was dismantled at the beginning of the year, but is being reconstructed and will start with 672 retorts.

In Kansas the J. B. Kirk Gas & Smelting Co. rebuilt several blocks of the old Lanyon smelter at Iola and operated it until June 30, when it was purchased by the United States Smelting Co., which also purchased, on June 15, the plant of the Altoona Zinc Smelting Co. A new smelter constructed on the site of the old plant of the La Harpe Spelter Co. by the Nicholson Construction Co. was likewise purchased by the United States Smelting Co. Additional retorts are under construction at all three plants, and, when completed, will increase the smelting capacity by 6,000 retorts over that at the beginning of the year. At Caney the American Zinc, Lead & Smelting Co. is operating 948 additional retorts and has 1,524 under construction, which will be completed in September. At Dearing the same company has added 640 retorts. The Cherokee Zinc Co. reopened the old smelter at Bruce, with 896 retorts, and it was purchased in July by the Cherokee Smelting Co. The Pittsburgh Zinc Co. is building 448 additional retorts. The Joplin Ore & Spelter Co. purchased the old Cockerill smelter at Pittsburg, rebuilt the furnaces, and replaced the hand roasters by two mechanical roasters. The plant of the Chanute Zinc Co. was taken over by the Chanute Spelter Co.

In Oklahoma the Bartlesville Zinc Co. is adding 2,016 retorts at Collinsville. The National Zinc Co. added 710 retorts at Bartlesville, and the United States Zinc Co. added 2,400 retorts at Sand Springs and is building 1,600 more. The Kusa Spelter Co. is building a smelter at Kusa, a new town in a gas and coal belt about 5 miles east of Henryetta. Five blocks of 660 retorts each are under active construction, and the company expects to have 1,980 retorts in operation in September and 1,320 more in October. It is probable that on the completion of the plant work will immediately be begun on another unit of the same capacity.

In Colorado the United States Zinc Co. added 320 retorts to the plant near Pueblo and is building 320 additional retorts.

SMELTERS IN GREAT BRITAIN.

The following list of active smelters in Great Britain has been checked and brought up to date by a correspondent of the United States Geological Survey.[1] Like the list of zinc smelters in the United States it includes all plants producing spelter by distillation or electrolysis, whether from ore or ashes and drosses. A large number of smelters which recover spelter from secondary materials by remelting, "sweating," or other ways, is not included.

[1] It is included here because of the wide interest in information regarding zinc-smelting capacity.

Active zinc smelters in Great Britain in 1915, with approximate annual capacity.

Name.	Locality.	Short tons.
British Metals Extraction Co	Llansamlet, near Swansea, Wales	2,000
Brunner, Mond & Co. (Ltd.) [a]	Winnington, England	
Central Zinc Co	Seaton-Carew, England	
Dillwyn & Co	Llansamlet, near Swansea, Wales	9,000
English Crown-Spelter Co	Port Tennant, near Swansea, Wales	9,000
John Lysaght (Ltd.)	Netham, Wales	3,000
Swansea Vale Spelter Co. (Ltd.)	Llansamlet, near Swansea, Wales	2,000
Vivian & Sons	Morriston, near Swansea, Wales	9,000
Williams, Foster & Co., and Pascoe, Grenfell & Sons (Ltd.).	Upper Bank, Swansea, Wales	6,000

[a] Spelter recovered by electrolysis.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

Owing to the disturbed conditions in Europe no figures of the world's spelter production are available. For convenience the following tables are repeated from the zinc report for 1913.

The following totals, apportioned according to the country where smelted and not according to the source of the ore, are the figures of Henry R. Merton & Co., of London, taken from the annual statistical publication for 1913 of the Metallgesellschaft, the Metallurgische Gesellschaft, A.-G., and the Berg und Metallbank Aktiengesellschaft of Frankfort on the Main, Germany, except that the figures for the United States are those of the United States Geological Survey:

The world's production of spelter, 1905–1913, by countries, in short tons.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913
Australia	.....	1,131	1,098	1,198	.....	560	1,904	2,531	4,105
Austria and Italy	10,315	11,883	12,522	14,063	13,931	14,666	18,602	21,609	23,928
Belgium	160,496	168,067	170,307	181,851	184,194	190,233	215,050	220,678	217,928
France and Spain	55,524	59,293	61,438	61,512	61,859	65,191	70,791	79,543	78,289
Germany	217,356	225,997	230,058	239,062	242,594	251,046	276,008	298,794	312,075
Great Britain	56,140	57,971	61,286	60,029	65,422	69,531	73,806	63,086	65,197
Holland	15,176	16,150	16,526	19,107	21,548	23,121	25,059	26,380	26,811
Norway	.....	.....	.....	.....	.....	.....	7,363	8,959	10,237
Poland	8,422	10,595	10,735	9,740	8,758	9,514	10,952	9,659	8,389
United States	203,849	224,770	249,860	210,424	255,760	269,184	286,526	338,806	346,676
Total	727,278	775,857	813,830	796,896	854,066	893,046	986,061	1,070,045	1,093,635
United States percentage of world's production	28.0	29.0	30.7	26.4	29.9	30.1	29.1	31.7	31.7

PRODUCTION OF SECONDARY SPELTER IN EUROPE.

The following table of the production of secondary spelter in Europe is calculated to short tons from a table published by Rudolf Wolff, Kreuger & Co., of London. It includes the output of the larger regular producers only. The production of the United States is included for comparison.

Production of secondary spelter in Europe and United States, 1905–1913, in short tons.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913
Austria-Hungary	3,505	3,674	3,931	3,315	3,102	2,934	3,282	3,282	2,822
Belgium	4,044	4,473	3,620	4,295	3,564	3,406	3,288	4,138	3,366
Denmark	.....	.....	.....	.....	.....	224	1,184	1,353	1,374
France	14,304	14,898	15,130	20,309	20,467	20,691	24,345	25,077	20,490
Germany	9,689	11,040	11,316	13,273	14,943	15,133	16,022	21,093	18,405
Great Britain	7,913	7,644	7,168	8,714	8,454	7,605	9,296	7,963	5,992
Holland	2,268	2,800	2,957	2,923	2,184	2,610	2,722	3,730	2,822
Russia	1,680	.....	1,680	1,680	.....	.....	.....	.....	.....
United States	.....	.....	18,841	16,970	33,040	41,223	40,513	52,251	50,005
Total	43,403	44,529	64,643	71,479	85,754	93,826	100,652	118,887	105,995

WAR USES OF ZINC.

The war has developed an unexpectedly large demand for zinc, owing chiefly to the overwhelming use of shrapnel and of huge artillery. Spelter as a 30 per cent component of brass is used in the equipment of war vessels of all sorts, in the mountings and fittings of artillery of all kinds, in the fittings of automobiles and aeroplanes, in cartridge cases for shrapnel, for rapid-fire machine gun, and for small arms. Of these probably the chief use is in shrapnel cases. Contrary to the statement sometimes made, these can generally be reused as much as 30 or 40 times, provided circumstances permit their being saved. The conservation and reuse of old shrapnel and cartridge cases should eventually lead to a reduction in the demand for spelter for such purposes. Their storage after the war may result in such an accumulation of old brass as to affect the market for both copper and spelter.

There is a heavy demand for zinc sheets for export to Europe, but it is not probable that the war is responsible for any large part of this demand. Sheet zinc is used to line powder cases and ammunition boxes and magazines. It is not likely to be employed extensively in roofing the temporary barracks and other buildings and trench shelters, the cheaper galvanized iron being available for such purposes. It is probable that the heavy demand results from the ordinary consumption of sheet zinc, which just now has to be supplied almost altogether, if not wholly, by the United States.

The following extract from the Iron and Coal Trade Review will give some idea of the quantity and proportions of copper, lead, and zinc used in making shrapnel and ammunition for small arms:

A British 18-pounder, or 3.3-inch shrapnel, requires 5 pounds 9⅛ ounces of brass containing 66 to 70 per cent copper, or nearly 3¾ pounds. A small copper band around the shell adds 4¾ ounces, making the total copper 4.04 pounds. Spelter consumption per shell of this size is about 1.87 pounds. Lead bullets weighing 7.92 pounds and composed of 7 parts lead to 1 antimony, constitute the metal load of the projectile. Estimating the total orders for shrapnel and other shells placed in the United States by Europe at 25,000,000 shells, these orders would call for a total of 101,000,000 pounds of copper, 46,750,000 pounds of spelter, and 173,250,000 pounds of lead. Actually the metal consumption is larger, as a fair proportion of the shells are 4.7-inch howitzer shells, using more brass; some 6-inch, 7½-inch, and probably 9-inch shells are also being made. Rifle cartridges are composed mainly of copper, there being 1 pound of it used in making 24 Lebel cartridges, a type widely used by the French army. Every 125 of these cartridges consumes 1 pound of spelter and a small amount of nickel.

WAR PRICES OF ZINC.

The outbreak of the war was preceded in the United States by 10 months of slowly declining prices for spelter and of gradually increasing stocks of that metal, so that the price of spelter immediately before the declaration of war was well under 5 cents, and the stocks of spelter at the midyear were over 64,000 tons. The price of spelter responded sharply to the scarcity of the metal in London consequent upon the closing down of the usual European sources, and there were heavy exports in September. The price took a rapid drop, however, to the lowest point of the year in October, caused probably by partial recovery from the spelter panic in London manifesting itself in lessened demands for export. From this point there was a sharp recovery and, with increased demands from abroad, the price rose to the unprecedented figure of 26.5 cents per pound early in June, 1915, only to recede to 11 cents per pound by the middle of August.

There are no published prices of high-grade spelter, so much in demand for the manufacture of munitions, but it ordinarily commands about 2 cents premium over the ordinary or prime western grade. Under the stimulus of the war demand, however, it has brought extremely high prices, at one time being sold at 40 cents per pound, while common spelter was 25 or 26 cents per pound. There is now a better supply of this grade available, through double distillation and other refining, and also through a slight lowering of the requirements, so that the premium now is much more moderate.

The price at Waterbury, Conn., of the special grade for brass through 1914 averaged 2.3 cents per pound above prime western spelter at New York. The differential during the period from February to September, inclusive, 1915, has ranged from 3 cents to nearly 5 cents, averaging 3.42 cents per pound.

The price of sheet zinc, so largely in demand for Europe, has followed in a much accentuated way the general course of the price of spelter. Through 1914 sheet zinc was worth about 2.5 cents per pound more than the ordinary grade of spelter. During the first eight months of 1915 sheet zinc has ranged from 2.5 cents to 8.75 cents, and has averaged 3.6 cents per pound above prime western spelter.

Zinc dust has commanded a high price in the United States during the war for just the opposite reason that spelter has. Prior to the war most of the zinc dust used in this country was imported from Germany and Belgium. After the war began it was some time before the American smelters arranged to take care of the local market, and in the meantime the price went very high. During the first half of 1914 zinc dust ranged from 5.75 to 6 cents per pound. At the outbreak of the war zinc dust rose to 19 cents, but with the increase of production in America it dropped again to 9 cents at the close of the year. In March, 1915, the price of zinc dust began to go up, and in the first two weeks of June more than doubled, rising from 17 to 40 cents. There was a decline of a few cents, but by the last week in July the price had settled back to 38 to 40 cents per pound, at which it has since remained.

WAR EXPORTS OF ZINC.

The following tables of exports of zinc and zinc manufactures, repeating in part tables given elsewhere in this report but including figures later than the year to which this report pertains, are segregated here to show the effect of the war on the zinc industry. The tables arranged by 6-month periods, including as they do one period before the war began and two periods since the beginning of the war, show very well the exports of zinc in munitions and zinc for manufacture into munitions abroad. The exports of spelter and sheet zinc rose from less than 1,000 tons in the period before the war to about 70,000 tons in each period since the war began. In some of the exports, like cartridges and manufactures of zinc and brass, the actual weights of the zinc contained is not known, hence values only can be given. The total value of exports of zinc and articles containing zinc rose from $6,000,000 in the first period to $17,000,000 in the second period and to $44,000,000 in the third period.

Exports of zinc from the United States by six-month periods, 1914–15, by classes, in pounds.

	1914				1915	
	January–June.		July–December.		January–June.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
DOMESTIC.						
Zinc ore	16,083,200	$275,184	6,137,600	$113,280	1,355,200	$24,791
Spelter and sheets	1,659,858	100,657	127,954,164	8,440,011	128,735,815	11,627,295
Zinc dross	572,477	29,084	4,498,590	211,860	5,863,250	345,387
Zinc manufactures	.....	82,254	.....	128,654	.....	1,047,975
Brass, old, for remanufacturing	13,535,666	1,437,763	7,103,735	663,107	8,662,272	912,896
Brass, bars, plate, and sheets	3,084,938	443,187	4,030,869	465,966	36,251,304	5,683,217
Brass, articles made from	.....	1,862,515	.....	1,894,373	.....	10,924,990
Cartridges	.....	1,896,415	.....	4,670,707	.....	13,043,498
FOREIGN.						
Zinc ore, contents	279,000	5,909	.....	.....	.....	.....
Zinc, block, pigs, and old	55,118	2,634	10,825,453	209,602	11,406,833	336,099
Zinc dust	34,212	1,775	322,050	15,697	227,408	22,680
Zinc manufactures	.....	53	.....	18,491	.....	54,124
Brass, old, for remanufacturing	12,585	1,586	1,068	135	.....	.....
Zinc used in articles exported with benefit of drawback	3,761,879	[a] 198,400	6,200,279	[a] 330,500	510,678	[a] 65,000
Total	.....	6,337,416	.....	17,162,383	.....	44,087,952

[a] Represents the value of the metal used in making the articles exported with benefit of drawback.

Exports of zinc from the United States, by six-month periods, and by destination 1914–15, in short tons.

Destination.	Spelter and sheet zinc.					
	January–June, 1914.		July–December, 1914.		January–June, 1915.	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
Canada	.....	167	3,383	539	2,918	382
Great Britain	45	.....	40,802	2,897	31,100	3,477
France	.....	.....	8,463	1,902	15,849	1,396
Italy	.....	.....	1,651	.....	2,717	448
Germany	84	.....	.....	.....	.....	.....
Russia	667	.....	4,152	.....	6,671	.....
Japan	.....	.....	456	.....	187	.....
Other countries	34	.....	5,070	75	4,926	.....
Total	830	167	63,977	5,413	64,368	5,703
Grand total	997		69,390		70,071	

Exports of zinc from the United States, by months, 1914–15, in short tons.

Month.	Spelter and sheet zinc.		
	Domestic.	Foreign.	Foreign lead used in articles exported with benefit of drawback.
1914.			
January	230	28	1,881
February	18	.....	
March	146	.....	
April	60	.....	
May	107	112	
June	269	27	
July	157	.....	3,100
August	3,448	319	
September	19,045	1,120	
October	10,259	1,140	
November	12,747	957	
December	18,321	1,877	
Total	64,807	5,580	4,981
1915.			
January	15,299	84	255
February	15,002	2,016	
March	8,120	1,136	
April	8,842	77	
May	7,635	1,104	
June	9,470	1,286	
July	5,981	1,876	.....
August	6,938	757	.....
September	8,653	1,513	.....

STATISTICAL POSITION OF SPELTER AT CLOSE OF 1914.

The following discussion of the spelter situation at the close of 1914 was published in the advance statement of the production of spelter in the United States, given out March 25, 1915. It is repeated here for reference:

The unprecedented and spectacular rise in the price of spelter in January and February of 1915 has caused the statistical position of spelter to be examined as never

before. The large stocks at smelters at the beginning of 1914, the much larger stocks at smelters at the midyear, and the great demands for zinc for export for war purposes have served to augment the deep interest in this metal.

The production of primary spelter made a substantial gain in 1914, and this, taken in conjunction with the large stocks, made available a far greater supply of primary spelter than ever before. Although the production of secondary spelter fell off markedly, nevertheless the total spelter available for consumption was the greatest in the history of the industry. Only the enormous exports of spelter for use in the war prevented a great increase in stocks. As it was, stocks were greatly reduced from the quantities in hand at the first of the year and the midyear, and at the close of the year were only moderately large. The apparent consumption of primary spelter was slightly larger than in 1913, and seems a reasonable figure.

The relatively small stocks at the close of 1914, in the face of the very large quantity of spelter available for consumption, might suggest that there were large "concealed" stocks of spelter in the hands of consumers and brokers. In 1912 the quantity of spelter available for consumption was very great, yet at the close of the year there were smaller stocks than for many years. Later events showed that on the strength of the rising market during the year large stocks had been laid in by consumers and others, which are not taken into account in the statistics. In 1913 there was again a large quantity available for consumption, but owing to declining prices of spelter the concealed stocks in consumers' hands satisfied the demands of the market, and at the smelters the large stocks accumulated which are shown in the statistics for that year. It will be observed, however, that large concealed stocks must necessarily be accompanied by an abnormally large apparent consumption. The apparent consumption for 1914, as shown by the figures above, is not abnormally large.

However, if it could be shown that the spelter-consuming industries were at a low ebb and probably absorbed only a small fraction of their normal consumption, then it would appear probable that the apparent consumption given above, though not over large, might represent a considerable quantity which had been withdrawn from the market for speculative purposes. It has been claimed that the brass industry ran on a 60 per cent basis during the latter part of 1914, and at the same time the iron and steel industry (including galvanized products) was on a 50 per cent basis. These figures seem too pessimistic. Responses from a limited number of representative and important interests indicate that the consumption of spelter in galvanizing in 1914 was about 90 per cent of what it was in 1913, and that the consumption of spelter in brass making was about 88 per cent that of 1913. These two industries probably account for about 80 per cent of the spelter consumption of the United States. If the considerable decrease in the quantity of secondary spelter recovered in 1914 be borne in mind, it does not seem probable that there can be any large quantity of concealed spelter stocks in existence. A consideration of the total apparent consumption of spelter for a period of years leads to the same conclusion.

To estimate the total apparent consumption of spelter in the United States, the production of secondary spelter, both redistilled and remelted, should be taken into account. The stocks of secondary spelter are not available, so that consumption of secondary spelter must be assumed to be the same as the production, which must be very nearly the fact, for the reason that secondary smelting interests are generally small. The annual figures of apparent consumption of primary spelter and of the production of secondary spelter are given below. The figures for 1907 and 1908 are not used, because the figures of production of secondary spelter for those years are possibly not complete. If used they would apparently result in a somewhat lower average consumption and indicate a somewhat larger annual increase.

Total consumption of spelter, 1909–1914.

Year.	Apparent consump- of primary spelter.	Production of second- ary spelter.	Approxi- mate total spelter consump- tion.	Estimated normal total con- sumption of spelter.
1909	270,730	33,040	303,770	285,000
1910	245,884	41,223	287,107	304,000
1911	280,059	40,513	320,572	322,500
1912	340,341	52,251	392,592	341,000
1913	295,370	50,015	345,385	360,000
1914	299,130	42,615	341,745	378,500
Total			1,990,876	1,991,000
Average			331,813	

From the figures of approximate total consumption for 1909–1914 given above we may make an estimate of the normal consumption of spelter for those years and the annual normal increase. The average yearly approximate consumption for the period is 331,813 tons. The consumption for 1912–1914 is about 84,000 tons in excess of the average for the whole period, and the consumption for 1909–1911 is about 84,000 tons less than the average. From these facts we may readily determine the normal annual increase and can then estimate the normal consumption of spelter, both primary and secondary, as given in the last column of the table above. The normal or prospective consumption of spelter for 1914 is seen to be 37,000 tons greater than the indicated actual consumption, from which it is to be inferred that large concealed stocks of spelter at the close of 1914 are not probable.

If spelter-consuming industries in the United States enjoy prosperous conditions in 1915, so that the total spelter consumption makes its normal gain (which, however, in view of the high price of spelter and the resulting effect on domestic consumption, is scarcely probable), figured on the totals for the last six years, as shown in the last column of the table above, the total domestic spelter consumption for 1915 would approximate 397,000 tons. If to this we add a year's domestic exports at the rate shown since the beginning of the war in Europe, 180,000 tons, and a year's foreign exports at the rate during the latter half of 1914, equal to 17,000 tons, we get 594,000 tons as the possible demand for spelter. This, however, is not the maximum possible quantity to be demanded. Attention was directed by the United States Geological Survey in a press bulletin, in August, 1914, to the opportunity for the American zinc industry to supply the major part of 222,000 tons of export spelter a year as long as the war lasts. As pointed out above, exports of spelter for seven months have been made at the rate of 197,000 tons yearly. Moreover, there remains the possibility of the trade in galvanized sheets, wire, and products with the southern continents and Asia. So far this has not been touched. The exports of galvanized sheets in 1914 were 45,318 short tons, compared with 86,475 tons in 1913. The exports of barbed wire, plain and galvanized, were 105,078 tons, as compared with 107,586 tons in 1912. When the United States comes into its share of the trade in galvanized products with the southern continents and Asia, the domestic consumption of spelter will be increased and will in turn increase the total possible demand for zinc given as 594,000 tons above.

On consideration, the domestic smelting capacity seems scarcely more than equal to this possible demand. The total number of ordinary retorts completed and contemplated at the close of 1914 is 124,016. Some of those contemplated can not be completed before the latter part of the present year. If we estimate the average capacity per retort as 4¼ tons of spelter per year, the capacity of 124,016 ordinary retorts together with the large retorts listed is approximately 535,000 tons. Add to this 20,000 tons of stocks on hand and 30,000 tons of remelted spelter, we get 585,000 tons. If we take into account that the maximum smelter capacity indicated above can not be reached until the latter part of the year, and consider the possibility of increased demand for galvanized products, it seems very improbable that there will be any surplus smelter capacity or accumulation of spelter stocks during the year. Apparently a continued decline in prices can come about only by a slackening in the foreign demand for spelter for war purposes.

It remains to consider whether the zinc resources of the United States together with the contiguous countries usually drawn upon will be equal to the possible demands of the immediate future. The total recoverable zinc available for spelter and the production of primary spelter for 1907–1914 are given in the following table:

Zinc available for spelter in the United States, 1907–1914, in short tons.

	Recoverable zinc content of domestic ore.	Recovered zinc content of imported ore.	Total recoverable zinc content of ore available in United States.	Zinc content of pigments made from ore.	Total recoverable zinc available for spelter.	Primary spelter production.
1907	259,951	[a]29,544	289,495	56,931	232,564	249,860
1908	234,526	20,399	254,925	48,004	206,921	210,424
1909	305,423	26,715	332,138	54,139	277,999	255,760
1910	327,712	19,492	347,204	50,660	296,544	269,184
1911	345,260	17,619	362,879	46,376	316,503	286,526
1912	378,816	16,498	395,314	62,876	332,438	338,806
1913	418,832	9,433	427,815	67,699	360,116	346,676
1914	.....	9,729	.....	69,871	.....	.....
Total	.....	.....	.....	.....	2,023,085	1,957,236
Apparent unused surplus	.....	.....	.....	.....	65,849	.....

[a] Does not include all the zinc recovered from imported ore in the form of pigments.

The average yearly increase in recoverable zinc content of domestic ore for the period 1907–1913, inclusive, is 26,405 tons. No figures are available for the zinc content of ores mined in 1914. Adding the average yearly increase for two years to the output of 1913 we get 471,192 tons as a normal estimate of the output of domestic mines of 1915. Adding 10,000 tons as probable imports in ore, and subtracting 70,000 tons as probable zinc content of pigments we get 411,000 tons as the probable zinc in ore available for spelter in 1915. To this should be added the 20,000 tons of spelter stocks on hand at the beginning of 1915, making 433,000 tons available. This is to be set-off against a possible demand for 594,000 tons as pointed out above. It will be observed from the table above that the total recoverable zinc available for spelter for 1907–1913 was about 66,000 tons in excess of the actual production of spelter for the same period. This is to be accounted for as increased ore stocks at the large new smelters, oxide plants, and separation plants which have been built since 1907, and is in large part available for immediate consumption. Adding this to the 433,000 tons, we should have roughly 500,000 tons supply available for treatment in 1915. To this there is to be further added the production of secondary spelter, which reached 52,251 tons in 1912, and could no doubt be expanded to 60,000 tons or more if the occasion arises. So that if the United States is called upon in 1915 for the possible supply of 594,000 or even 600,000 tons of spelter, the zinc will be probably at hand without increasing the mine production above the normal, to furnish nearly 560,000 tons of it. The remainder would easily be supplied by increased production from Montana, Idaho, Colorado, New Jersey, Tennessee, and other States, under the stimulus of high prices. In the Joplin district alone much lean sheet-ground territory not recently operated would become productive under continued high prices, to say nothing of increased production from operating and new mines.

Zinc ore was imported from Mexico at the rate of less than 200 tons of zinc content per month for the first eight months of 1914. Conditions limiting the shipment of zinc ore from that country have recently eased up somewhat and the imports for the period September, 1914, to including February, 1915, have averaged 1,600 tons of zinc content, so that a larger supply than for the last two years is to be expected from that country. The available supply from Canada will no doubt be largely increased by the high prices.

In conclusion, it appears that spelter is in a highly advantageous position as far as the statistics afford evidence, and the only danger to be apprehended is that the prevalence of high prices may so limit the domestic consumption as to partly offset advantage gained from the increased foreign demand. The high price of galvanized sheets, for instance, has led some rolling mill operators to advise their customers to substitute heavier black sheets coated with paint. It further appears that the zinc resources of the United States are amply able to satisfy any possible demand that is likely to be made upon them in the immediate future, without drawing upon the zinc tailing piles of Australia.

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Zinc imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the zinc goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the zinc may be withdrawn for consumption by payment of duty, or it may be smelted in bond, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The zinc entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption, which are expressed in the same terms in which they were imported. The zinc imported for consumption may be actually used in the country or it may be manufactured and exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below, showing foreign zinc exported in manufactures with benefit of drawback, the zinc is shown in the form in which it was originally

imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign zinc given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. A somewhat more detailed explanation of warehouse transactions is given in the chapter on lead in Mineral Resources for 1914. The following tables of imports and exports of zinc and of zinc remaining in warehouse are made up from the publications and records of the Bureau of Foreign and Domestic Commerce.

The quantity of zinc remaining in warehouse at the close of the years prior to 1909 has been negligible, but since all zinc ore became dutiable on August 6, 1909, the quantity of bonded zinc has largely increased.

Practically all the zinc remaining in warehouse, as given in the table below, is credited to the port of Kansas City, Mo., and is in possession of the bonded zinc smelters of Kansas and Oklahoma.

Zinc remaining in warehouse Dec. 31, 1909–1914.

Year.	Ore and calamine.			Blocks, pigs, and old.	
	Short tons.	Zinc content.	Value.	Quantity.	Value.
		Pounds.		*Pounds.*	
1909	2,813	2,255,341	$36,384	78,667	$4,021
1910	2,603	2,572,122	61,730	61,146	3,406
1911	10,177	6,978,088	137,055	63,454	4,049
1912	3,076	2,479,565	62,089	.....	.....
1913	7,531	1,930,425	68,726	.....	.....
1914	6,728	6,987,676	90,257	221,994	11,100

The figuers for 1910 and 1911 are exclusive of the zinc contained in certain other ores entered at New York, as explained later in the discussion of the table of general imports of zinc.

IMPORTS.

Zinc imported and entered for consumption in the United States, 1902–1914, in short tons.

Year.	Block or pigs.		Sheets.		Old.		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902	448	$36,536	68	$8,339	157	$8,299	$32,708	$85,882
1903	202	19,161	129	8,537	163	11,772	10,376	49,846
1904	341	34,211	17	2,230	36	3,247	10,394	50,082
1905	428	46,295	14	1,953	86	5,110	8,253	61,611
1906	1,021	240,632	22	3,236	79	7,647	2,904	254,419
1907	1,709	220,474	52	7,158	122	8,582	8,516	244,730
1908	776	78,160	37	4,570	37	2,014	5,645	90,389
1909	9,419	805,087	117	13,510	238	9,999	6,488	835,084
1910	989	95,410	262	36,641	257	17,549	1,526	151,126
1911	323	38,322	296	55,211	104	8,609	7,981	110,123
1912	10,719	1,239,574	728	102,073	147	13,748	8,489	1,363,884
1913	5,165	565,215	223	43,497	275	17,850	5,474	632,036
1914	195	21,140	277	32,004	388	26,512	4,464	84,120

The foregoing table does not include zinc dust imported for consumption. Prior to August 6, 1909, zinc dust was entered free of duty under "articles in a crude state used in dyeing and tanning," and as such was not separately enumerated by the Bureau of Foreign and Domestic Commerce. Under the tariff of 1909 zinc dust

bore a duty of 1⅜ cents per pound and was separately enumerated under "imports for consumption," though included with spelter in the Monthly Summary of general imports. Under the tariff act of 1913 zinc dust bears an ad valorem duty of 15 per cent. The imports of zinc dust for consumption for the period August 6 to December 31, 1909, were 431,660 pounds, valued at $19,464. This quantity and value is included in the total for the year as given in the table below. The quantity of zinc dust imported for consumption since January 1, 1910, and its value are also as given in the table. The only statistics available for the time before August 6, 1909, are those of foreign countries relating to their exports of zinc dust to the United States. Among these countries are Germany, Belgium, France, Holland, and Denmark, but only in the reports of the first-mentioned country are the exports of zinc dust segregated from other exports. Germany has furnished much the larger part, amounting to about 95 per cent of the total imports of zinc dust. For this reason the zinc-dust exports from Germany to the United States from March 1, 1906, to August 5, 1909, inclusive, as compiled from the annual Statistik des Deutschen Reichs, Auswärtigar Händel, and shown in the following table, give a fair idea of the total consumption of zinc dust in the United States for that period.

Imports of zinc dust, 1906–1914, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906 [a]	1,818,576	$108,052	1911	3,426,161	$177,420
1907	1,893,090	106,386	1912	5,471,211	306,061
1908	2,625,238	136,136	1913	4,735,502	248,482
1909	2,520,740	130,662	1914	4,008,556	191,582
1910 [b]	2,985,088	136,749			

[a] March-December, 1906; for period preceding, zinc dust is not separately enumerated.
[b] Figures for 1910 and later years are imports for consumption.

In view of the general interest in the importation of zinc ores, a table is given below, showing the entry of such ores from Mexico and Canada for 1904–1914 by calendar years. These general imports of zinc ores differ from "imports for consumption" by the difference in stock in bonded warehouse at the beginning and close of the year and by exports from warehouse.

Imports for consumption of zinc ore and calamine, 1909–1914.

Year.	Containing less than 10 per cent of zinc (duty, free).		Containing from 10 to 20 per cent of zinc (duty, ¼ cent per pound).		Containing from 20 to 25 per cent of zinc (duty, ½ cent per pound).		Containing 25 per cent or more of zinc (duty, 1 cent per pound). [a]	
	Zinc content.	Value.	Zinc content.	Value.	Zinc content.	Value.	Zinc content.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1909 [b]			333,144	$8,690	225,302	$5,632	9,390,620	$161,430
1910	31,899	$698	174,697	4,053	2,355,748	25,127	39,921,939	713,684
1911	77,383	1,411	377,884	8,705	1,128,238	16,914	6,697,107	120,756
1912	44,308	1,141	1[illegible]2 938	3,045	916,865	6,734	20,656,027	433,570
1913			[b] 90,924	2,067	[c] 618,568	4,395	[a] 8,185,029	193,014
1914							11,095,276	149,503

[a] Includes all classes after Oct. 4, 1913.
[b] For period July 1–Dec. 31 only.
[c] For period Jan. 1–Oct. 3, 1913; Oct. 4–Dec. 31, included in class "containing 25 per cent or more of zinc."

The statistics of general imports as published by the Bureau of Foreign and Domestic Commerce are based on "consular invoice" or "declaration," which is only a close approximation to actual weights and values. The true weights and values of all dutiable articles are determined when the duties are paid, and the correction is applied as "additions by liquidation" or "deductions by liquidation." On free articles this correction is not made. Prior to 1909 zinc ore was in large part undutiable, and in that part of 1909 prior to August 6 a portion of the imports of zinc ore was free. The correction by liquidation for the dutiable zinc ore imported during 1909–1912 is available, but, owing to special instructions followed in one customs district, to apply the correction by liquidation would result in a considerable duplication of imports. The following figures are taken directly from the Monthly Summary of the Bureau of Foreign and Domestic Commerce without the liquidation correction:

General imports of zinc ore from Canada and Mexico, 1904–1914, in short tons.

Year.	Canada.		Mexico.		Total.	
	Ore.	Zinc content.	Ore.	Zinc content.	Ore.	Zinc content.
1904	.....	.....	2,264	.....	2,264	.....
1905	4,063	.....	18,074	.....	22,137	.....
1906	423	.....	59,991	.....	55,414	.....
1907	1,112	.....	102,005	.....	103,117	.....
1908	7,406	.....	46,351	.....	53,757	.....
1909	10,024	.....	104,826	.....	114,850	.....
1910	4,749	1,922	67,818	23,517	72,626	25,439
1911	2,359	947	36,847	14,986	39,116	15,933
1912	8,015	3,661	35,925	14,206	43,940	17,567
1913	8,899	3,498	17,493	6,159	[a] 31,416	13,497
1914	11,250	4,467	20,705	7,663	31,962	12,132

[a] Includes also 1,674 tons of zinc ore from the Netherlands, containing 1,599 tons of zinc; 1,558 tons of ore from Germany, containing 841 tons of zinc; and 1,792 tons of ore from Siberia, containing 1,397 tons of zinc.

The foregoing figures showing imports of zinc ore in 1910 do not include 10,431 short tons of ore that carried 2,645,111 pounds of zinc as an accessory constituent, an average of less than 13 per cent, which was lost in smelting the ore and hence for the purpose of this report can not be classed with zinc ore imports so long as the present metallurgical treatment of that ore prevails. Similarly, the figures for 1911 are exclusive of 25,769 tons of other ore, carrying 6,283,437 pounds of zinc, and those for 1912 are exclusive of 18,245 tons of other ore, carrying 4,862,508 pounds of zinc. The duties on the zinc contents of this ore have since been refunded and the bonds canceled. The ore was shipped from South American ports and largely entered through the port of New York. It is shown in the monthly Summary of the Bureau of Foreign and Domestic Commerce under the heading of "Merchandise remaining in warehouse," mostly at New York. Such ores have entered free and have not been enumerated since 1912.

Zinc oxide imported and entered for consumption, 1901–1914, in short tons.

Year.	Dry.	In oil.	Year.	Dry.	In oil.
1901	1,800	64	1908	2,318	105
1902	1,636	82	1909	3,060	268
1903	1,744	83	1910	3,069	168
1904	1,283	112	1911	2,506	274
1905	1,718	171	1912	2,675	262
1906	2,096	146	1913	3,291	142
1907	2,656	181	1914	2,461	168

Imports of old brass fit only for remanufacture, 1903–1914, in pounds.

[Average composition about one-third zinc and two-thirds copper.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	1,216,683	$154,260	1910	6,144,564	$786,684
1904	2,659,054	310,311	1911	3,605,106	445,116
1905	9,676,798	1,169,320	1912	6,596,957	639,045
1906	12,938,205	1,891,126	1913	8,726,142	907,521
1907	7,957,015	1,344,753	1914	5,129,030	487,542
1908	2,714,155	355,335			
1909	4,672,575	579,454	Total	72,036,384	9,069,467

EXPORTS.

DOMESTIC EXPORTS.

The practice of the Bureau of Foreign and Domestic Commerce is to class all exports of zinc articles made in this country as domestic exports, whether the zinc be of domestic or foreign origin. Hence the following table of domestic exports is duplicated in part in a later table of foreign zinc in manufactures exported with benefit of drawback. The exports of zinc ore in the table below are of domestic origin and in recent years have all been from one mine in New Jersey. The exports of plates, sheets, pigs, or bars are likewise probably wholly domestic, since as shown later all the zinc in manufactures going out under drawback came in as blocks, pigs, and sheets, and the only manufacturing process which would put any of these into the class of exports referred to is rolling into sheets. But the zinc rolling mills in this country do not use foreign smelter, hence the conclusion that the plates, sheets, pigs, and bars of the table are of domestic origin. The zinc dross exports are no doubt in part of foreign origin, but in what proportion can not be determined. However, they are not duplicated in the drawback table. The exports of manufactures, of which the value is given, include the value of the whole of the manufactures exported with benefit of drawback, as well as whatever manufactures of domestic zinc may be exported.

Exports of domestic zinc ore and of domestic manufactures of zinc, 1902–1914, in short tons.

Year.	Zinc ore.		Plates, sheets, pigs, or bars.		Zinc dross.[a]		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902	55,733	$1,449,104	3,237	$300,557	.....	.....	$114,197	$1,863,858
1903	39,411	987,000	1,521	163,379	.....	.....	71,354	1,221,733
1904	35,911	905,782	10,147	1,094,490	.....	.....	117,957	2,118,229
1905	30,946	848,451	5,516	682,254	.....	.....	159,995	1,690,700
1906	27,720	733,300	4,670	583,526	15,887	$1,103,706	204,269	2,624,801
1907	[b] 20,352	579,490	563	75,194	9,593	560,944	186,203	1,401,831
1908	[b] 26,108	877,745	2,640	250,254	8,405	467,403	88,485	1,683,887
1909	[b] 12,455	412,300	2,566	263,010	7,069	477,112	69,751	1,222,173
1910	[b] 19,711	649,425	3,990	426,560	4,729	380,950	101,336	1,558,271
1911	[b] 18,281	642,884	6,872	810,099	4,246	348,176	134,518	1,935,677
1912	[b] 23,349	823,997	6,634	864,292	205	17,985	140,027	1,846,301
1913	[b] 17,713	631,991	7,783	955,667	28	1,457	145,984	1,735,099
1914	[b] 11,110	388,464	64,802	8,540,668	2,526	240,944	210,974	9,381,050

[a] Not separately enumerated prior to 1906.
[b] The exports consisted wholly of high-grade willemite ore from New Jersey.

Exports of zinc oxide, 1902–1914, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1902	5,358	$433,722	1909	14,846	$1,026,377
1903	7,215	578,215	1910	13,167	943,938
1904	8,157	628,494	1911	14,618	1,051,311
1905	11,280	810,203	1912	17,064	1,247,702
1906	15,578	1,149,297	1913	14,467	1,136,257
1907	13,257	1,069,924	1914	15,592	1,408,525
1908	12,008	845,070			

FOREIGN EXPORTS.

By foreign zinc exports is meant the exports of zinc of foreign origin which has been smelted or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total zinc exported from warehouse during the last ten years, the exports prior to that period being of insignificant proportions, and also the foreign zinc exported in manufactures with benefit of drawback for the same period. These two items—foreign zinc exported from warehouse and foreign zinc in manufactures exported with benefit of drawback—make up the total foreign zinc going out of the country. Zinc in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of zinc and the total imports of zinc constitutes the foreign zinc consumed in this country. It must be clearly understood in regard to this table that the zinc was not exported as zinc content of ore and blocks, pigs, etc., but as zinc smelted or manufactured from them. The reason for this is that the zinc in bonded customs warehouse is carried on the records until the bond is canceled in the same form in which the zinc was entered for warehouse. The zinc content of the foreign ore is, of course, exported as spelter and manufactures of zinc. Under present customs regulations zinc equivalent in quantity to the total recoverable zinc content must be exported to secure cancellation of bond. The quantities of zinc exported from warehouse are exact, but the quantities as given of zinc exported in manufactures under drawback are subject to wastage in manufacturing.

No record is kept of the form in which the zinc is actually exported, except of a portion of the articles manufactured from foreign zinc and exported with benefit of drawback. Unless the zinc is the constituent of chief value, the actual quantity of zinc is not recorded. But each shipment on which drawback is claimed is accompanied by a manifest of the imported zinc which was used in making the articles as well as the duty paid thereon. From these manifests is made up the statement of the total quantity of foreign zinc which went into manufactures exported with benefit of drawback, and for this reason the zinc is given in the form in which it was imported.

Exports of foreign zinc, 1905–1914, in pounds.

Year.	Exported from warehouse.					Exported in manufactures with benefit of drawback.
	Ore and calamine, zinc content.[a]		Blocks, pigs, and old.		All other manufactures.	Blocks, pigs, sheets, and all other manufactures.
	Quantity.	Value.	Quantity.	Value.	Value.	Quantity.
1905	.....	.....	38,753	$816	$1,015	.....
1906	.....	.....	2,779	252	1,962	4,469
1907	.....	.....	17,458	1,023	1,504	3,110,239
1908	.....	.....	16,748	964	4,635	2,468,365
1909	[a] 655,102	$6,429	12,569	752	521	610
1910	9,420,984	182,345	94,672	4,884	1,121	8,972,427
1911	21,636,916	476,233	915,823	21,141	2,701	6,157,328
1912	13,556,954	306,726	95,571	4,346	30,649	2,437,354
1913	10,812,921	214,437	1,240,769	66,919	6,231	14,918,040
1914	279,000	5,909	10,880,571	212,236	18,544	19,011,613

[a] After Aug. 6, 1909.

CONSUMPTION.

In the following tables, showing the consumption of spelter in the United States and in the world for the period 1898–1913, the figures of foreign consumption are computed from statistics published by the Metallgesellschaft for 1913. In those statistics consumption is calculated on the basis of production plus excess of imports over exports or minus excess of exports over imports, and altogether disregards smelter stocks. For the sake of comparison the consumption of the United States is calculated by both methods. Although in the long run the stocks carried over from one year are consumed in the next, and thus are equalized, it can not be gainsaid that for the individual year to take stocks into account gives greater accuracy. To obtain perfectly accurate figures of consumption, it would be necessary to consider the stocks in the hands of consumers and dealers and to take into account the secondary spelter consumed. No figures of foreign consumption in 1914 are available.

Consumption of primary spelter in the United States, 1908–1914, in short tons.

	1908	1909	1910	1911	1912	1913	1914
Supply:							
Stock Jan. 1—							
In bonded warehouses	2	9	39	31	32	43	.....
At smelters	26,364	19,613	11,167	23,201	9,049	4,474	40,659
Production	210,424	255,760	269,184	286,526	338,806	346,676	353,049
Imports	881	9,454	1,960	609	11,115	6,100	880
Total available	237,671	284,836	282,350	310,367	359,002	357,298	394,588
Withdrawn:							
Exports, foreign, from warehouse	8	334	4,758	11,276	6,286	6,027	5,580
Exports, foreign, under drawback	1,234	.....	4,486	3,079	1,219	7,459	4,981
Exports, domestic	2,640	2,566	3,990	6,872	6,634	7,783	64,807
Stock Dec. 31—							
In bonded warehouses	9	39	31	32	48	.....	111
At smelters	19,613	11,167	23,201	9,049	4,474	40,659	19,984
Total withdrawn	23,504	14,106	36,466	30,308	18,661	61,928	95,463
Apparent consumption	214,167	270,730	245,884	280,059	340,341	295,370	299,125

In considering the consumption of primary spelter there should be borne in mind the rapidly increasing quantity of secondary material, such as zinc skimmings, ashes, hard zinc, and scrap zinc, from which zinc is recovered in the form of spelter, alloy, pigment, or chemical, and so used again, thus affecting the consumption of primary spelter. The total quantity of secondary zinc recovered in 1914, so far as there is available record, was 84,607 tons, as compared with 89,528 tons in 1913. For details of the recovery of secondary zinc in 1913 and previous years, see under heading "Secondary zinc" in this chapter.

The consumption of spelter of foreign origin, both that made in this country from foreign ore and that imported directly as spelter, is a matter of much importance to American zinc producers and smelters. The following table gives this consumption of foreign spelter for the period from 1908 to date. A certain portion of the stocks reported by the smelters as on hand at the close of the year must consist of spelter made from foreign ores, and this has not been taken into consideration in the table, but although this would affect the consumption for any single year it will not impair the usefulness of a table covering the length of time here given.

Foreign zinc consumed in United States, 1908–1914, in short tons.

	1908	1909	1910	1911	1912	1913	1914
Supply:							
Produced from foreign ore	19,675	25,535	16,705	14,905	14,899	9,424	9,631
Stocks in bonded warehouse	2	9	39	31	32	48	.....
Imports	881	9,454	1,960	609	11,115	6,100	880
Total supply	20,558	34,998	18,704	15,545	26,046	15,572	10,511
Withdrawn:							
Exports from warehouse	8	334	4,758	11,276	6,286	6,027	5,580
Exports under drawback	1,234	.....	4,486	3,079	1,219	7,459	4,981
Stocks in warehouse	9	39	31	32	48	.....	111
Total	1,251	373	9,275	14,387	7,553	13,486	10,672
Consumption of foreign zinc	19,307	34,625	9,429	1,158	18,493	2,086	[a]—161

[a] The excess of withdrawals over supply may be accounted for by exports under drawback of articles manufactured from zinc imported prior to 1914.

World's consumption of spelter, by countries, 1907–1913, in short tons.

[Stocks disregarded except in the United States.]

	1907	1908	1909	1910	1911	1912	1913
Austria-Hungary	34,171	35,925	36,155	37,258	47,950	51,588	44,533
Belgium	60,627	74,936	71,209	84,326	81,240	85,098	84,216
France	76,720	85,956	73,744	62,059	90,389	90,389	89,286
Germany	192,792	198,580	207,343	196,320	241,734	248,899	255,734
Great Britain	154,653	152,627	171,408	195,989	193,674	204,146	214,508
Holland	4,189	4,189	4,409	4,409	4,409	4,409	4,409
Italy	7,496	9,257	9,039	8,929	11,133	11,795	12,015
Russia	19,290	19,946	20,282	27,447	31,856	30,754	36,707
Spain	5,180	5,512	4,960	4,630	5,291	5,181	6,503
Other countries	13,228	11,020	9,921	13,668	19,621	21,715	23,038
United States	226,969	214,167	270,730	245,884	280,059	340,341	295,370
Total	795,315	812,115	879,200	880,919	1,007,356	1,094,315	1,066,319

World's consumption of spelter, exclusive of secondary zinc, 1898–1914, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States percentage.
1898	108,199	106,185	422,070	528,255	20.10
1899	124,585	123,688	422,181	545,869	22.66
1900	99,399	102,414	420,858	523,272	19.57
1901	141,697	137,789	424,496	562,285	24.51
1902	152,682	154,138	465,391	619,529	24.88
1903	154,381	157,900	480,162	638,062	24.75
1904	180,911	176,804	520,506	697,400	25.36
1905	200,438	198,835	534,285	733,120	27.13
1906	220,781	221,142	556,882	778,024	28.42
1907	226,969	249,511	568,346	817,857	30.51
1908	214,167	207,423	597,948	805,371	25.75
1909	270,730	262,314	608,472	870,784	30.12
1910	245,884	257,910	635,035	892,945	28.88
1911	280,059	265,908	727,297	993,205	26.77
1912	340,341	335,782	753,974	1,089,756	30.81
1913	295,370	331,507	770,949	1,102,456	30.07
1914	299,125	278,561	.....	.....	.....

CUSTOMS DUTIES ON ZINC.

The Treasury Department has issued the following letter of instructions (T. D. 34280) to collectors of customs:

APPRAISEMENT OF ZINC IN ORE.

(1) Ores containing zinc, but no other recoverable metal, to be appraised at the price of the ore. (2) Ores containing zinc in quantities not commercially recoverable to be appraised as of no value. (3) Ores containing zinc and other metal, both the zinc and other metals being recoverable, to be appraised under the last provision of paragraph L, section 3, tariff act of 1913. (4) Invoices of zinc ore to show the contract basis of purchase.

TREASURY DEPARTMENT, *March 16, 1914.*

SIR: The department refers to your letter of October 22 last, relative to the appraisement of zinc contained in zinc-bearing ores.

It appears that there are several forms of zinc ore: (1) Straight zinc ore containing no other valuable metal than zinc; (2) zinc-bearing ore containing lead or other metals, but in such small quantities as not to be commercially recoverable; (3) zinc-bearing ore containing other valuable metals, both the zinc and the other metals being commercially recoverable at a profit; (4) zinc-bearing ore containing other metals, but the zinc not commercially recoverable, and in some instances a detriment, and the ore less valuable because of the presence of the zinc.

(1) In the first two instances, if there is an open-market value of the ore in the country from which exported, the price at which the ore is sold represents the value of the zinc contained therein, and is the value at which the zinc should be appraised. If such ores are not freely sold in the markets of exportation, recourse must be had to paragraph L and the value of the zinc determined according to the percentage of zinc based on the value of spelter in the United States, making due allowance for cost of transportation, duty, profit, smelting, and overhead expenses.

(2) Under the conditions stated in paragraph 3, when ores contain zinc and other valuable metals, if the price at which the ore is sold does not represent either the price of the zinc or other metals there is no market value for the zinc contained in the ore in the country from which exported. Recourse must therefore be had to paragraph L and the zinc contents appraised at the cost of the spelter in the United States, making allowance for the cost of transportation, duty, profit, smelting, and overhead expenses.

(3) When the zinc in an ore is not commercially recoverable or is a deteriment in the smelting of other metals, the department is of the opinion that such zinc is of no commercial value and that no duty accrues thereon.

It appears that most of the zinc ores are sold subject to assay and the price based on the amount of zinc contained therein; that at the time of shipment neither the purchaser nor the seller can state the exact amount to be paid for the particular shipment, and that it is impracticable, if not impossible, for the importer to state in the invoice and entry the exact value of the shipment. In such cases, the department is of the opinion that at the time of entry the importer should state the terms of his contract of purchase and the basis of payment, and that the entered value should be computed upon the basis of such contract after the assayer has determined the quantity of zinc in the importation, and that unless the appraiser advances the unit of price the appraised value should not be considered as exceeding the entered value, although the total value of the invoice may exceed the total value as estimated by the appraiser.

Respectfully, CHARLES S. HAMLIN,
Assistant Secretary.

(101088.)
Collector of Customs, Denver, Colo.

The recent heavy importation of zinc ores from Australia and elsewhere have necessitated some modifications in the foregoing instructions and these are now in course of formulation.

The United States Board of General Appraisers has ruled as follows (T. D. 35527) on the appeal of the United States Metals Refining Co. regarding duties assessed on small percentages of zinc in other ores:

ZINC IN ZINC-BEARING ORES.

"Copper ores containing zinc in percentages varying from 3.60 to 7.30 are properly dutiable under paragraph 162, tariff act of 1913. Congress, in framing said paragraph, saw fit to omit therefrom the provision admitting free of duty "zinc-bearing ores of all kinds, including calamine, containing less than 10 per cent of zinc," found in paragraph 193 of the act of 1909, thus making clearly manifest the legislative purpose to impose duty on all zinc contained in ores whether or not it is capable of being commercially recovered." (United States General Appraisers, New York, June 8, 1915.)

The merchandise in question consists of copper ore containing zinc in percentages varying from 3.60 to 7.30 per cent. Duty was levied on the zinc content at the rate of 10 per cent ad valorem—upon an appraised valuation thereof at 4 cents per pound—under the provisions of paragraph 162 of the act of 1913, and the importer claims that said ore is properly entitled to free entry under the provisions of paragraph 461 of said act on the ground that the quantity of zinc contained therein is negligible and not capable of being recovered or used. The pertinent provisions of the two paragraphs under consideration are as follows:

"162. Zinc-bearing ores of all kinds, including calamine, 10 per centum ad valorem upon the zinc contained therein: *Provided*, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper custom officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law * * *.

"461. Copper ore * * *."

An analysis of the ore contained in the various shipments in question was made by a chemist in the laboratory attached to the office of the appraiser at the port of New York, and upon the basis of his returns the assessment here complained of was made. That official, as well as the United States examiner attached to the same office, and who passed the ores in question, testified that the quantity of zinc contained in said ores was negligible.

There is also before us uncontradicted testimony that in smelting copper ores it is commercially impossible to recover zinc where the percentage thereof is as low as it is shown to be in the merchandise at bar; that as matter of fact the presence of zinc in such small quantities actually proves to be a detriment rather than an advantage,

in that it tends materially to lessen the value of the copper ores. As corroborative of this view, counsel for the importer invites attention to a circular issued by the Treasury Department and published as T. D. 34280, wherein classifying officers are advised to appraise as of no value ores containing zinc in quantities found not to be commercially recoverable, or where it is shown that the zinc content actually proves to be a detriment to the extent of lessening the value of the ores.

Counsel for the Government contends that the protests should be overruled, for two reasons: (1) That, inasmuch as the zinc content was appraised at 4 cents per pound, it can not now be held to be of no commercial value; (2) that the provisions of paragraph 162 were intended to apply to and cover the zinc content as found in the ore in its imported condition, without reference to the quantity thereof, which may or may not be determined to be commercially recoverable.

The question of the dutiability of the zinc content of ores was affirmatively decided by this board in G. A. 7049 (T. D. 30727), said ruling being subsequently upheld by the United States Court of Customs Appeals in Consolidated Kansas City Smelting & Refining Co. *v.* United States (1 Ct. Cust. Appls., 472; T. D. 31509). That case arose under the tariff act of 1909, and involved the question whether ore containing lead and zinc, the latter over 10 per cent, was properly classifiable for duty based upon the ascertained quantities of both metals, the lead under paragraph 181 and the zinc under paragraph 193 of said act. After quoting at considerable length from the testimony to show "that ores may be both zinc-bearing ores and lead-bearing ores, and that each of the ores may be recovered and the ore profitably manipulated for their recovery by the process of concentration and smelting several ores by the appropriate method," the court further said:

"* * * It is very clear from this that it was within the contemplation of Congress that ores which required mechanical treatment to concentrate them in preparation for the retort used in reclaiming the zinc should be dutiable in their crude state. Indeed, this language requires that all ores containing a greater quantity than 10 per cent of zinc must be treated as zinc ores and assessed under paragraph 193. As is pointed out by the Board of General Appraisers in their opinion, Congress has provided for a duty on the metal content of ores rather than on the recovered metal itself."

In enacting paragraph 162 of the present act it is clearly manifest that Congress intended not only to adopt as correct the judicial interpretation of the language of paragraph 193 of the act of 1909, but to further narrow its applicability and scope. Hence we find omitted from the present paragraph this provision "containing less than 10 per centum of zinc" found in its predecessor in the act of 1909. There can therefore be no question whatever concerning the congressional intention to impose a duty of 10 per cent ad valorem upon zinc-bearing ores of all kinds, including calamine, regardless of the quantity of zinc which may or may not be shown to be commercially recoverable.

The protests are accordingly overruled, and the decisions of the collector are affirmed.

PRICES AND VALUE.

PRICES.

The price of prime western spelter at St. Louis at the beginning of 1914 was 5.125 cents per pound and it rose gradually to 5.325 cents early in February, after which a long decline brought the price down to 4.75 cents per pound early in August. Shortly after the breaking out of the war spelter rose rapidly and by the last of August it was 6 cents, the highest point of the year; then through the influence of the 64,000 tons of stocks and because war orders did not materialize as quickly as expected, it dropped as rapidly and by the middle of October was 4.6 cents, the minimum price of the year. From this point the price continued to rise and closed the year at 5.5 cents per pound. The average price of prime western spelter in St. Louis in 1914 was 5.1 cents per pound as compared with 5.6 cents in 1913. The average price of spelter at St. Louis is used by the United States Geological Survey in calculating the value of the domestic production of spelter.

In the London market spelter opened at £21 10s. per long ton (4.68 cents per pound) and continued nearly on a level until the beginning of August when the London Metal Exchange was closed and there were no quotations until November. In the Ironmonger's Metal Market Yearbook, however, there are quotations for the week ending August 14, the highest of which, £33 per long ton (7.2 cents per pound), was the maximum price of the year. With the opening of the war, the United States became practically the only source of spelter for Great Britain, and hence the London and New York prices ran parallel to the close of the year, London prices averaging 0.38 cent per pound in advance of the St. Louis prices. The average London price for the 11 months of the year for which there were quotations was £22 19s. 6¼d. per long ton (5 cents per pound), but this is below the actual average for the year, for during the five weeks for which there were no quotations spelter was at the highest price of the year.

Zinc sheets through 1914 averaged at the mills in Illinois about 2½ cents per pound above prime western spelter at St. Louis.

The price of zinc dust at the beginning of the year was 6 cents per pound and the price dropped to 5¾ cents in March. When the war broke out the supply of zinc dust from Germany and Belgium was shut off and the price in the United States rose to 19 cents, as shown on another page. A number of American zinc smelters began to save and prepare zinc dust for market, with the result that the price dropped to 9 cents, at which it closed the year.

The following table giving highest and lowest prices of spelter in each month for the years 1902–1914, inclusive, is based on figures in the Iron Age prior to 1906. For 1906–1910 the figures are based on the daily quotations in the Engineering and Mining Journal. Beginning with 1911 the figures are taken from the monthly summaries of the Steel and Metal Digest. Prior to 1909 the quotations are from New York City, but for 1909 and after St. Louis prices are taken.

Monthly price range of prime western spelter, 1902–1914.

[Cents per pound.]

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.30	4.25	4.25	4.00	4.35	4.20	4.45	4.40
1903	4.90	4.55	5.05	4.97	5.75	5.05	5.75	5.50
1904	5.10	4.90	5.10	4.95	5.20	5.05	5.27	5.20
1905	6.20	6.10	6.15	6.10	6.15	5.87	6.00	5.75
1906	6.70	6.00	6.15	6.05	6.35	6.10	6.15	6.05
1907	6.80	6.70	6.90	6.70	6.90	6.75	6.80	6.55
1908	4.60	4.25	4.85	4.55	4.80	4.60	4.70	4.60
1909	5.20	5.075	5.075	4.525	4.625	4.55	4.95	4.60
1910	6.075	5.65	5.70	5.25	5.625	5.45	5.475	4.90
1911	5.425	5.275	5.55	5.25	5.525	5.30	5.325	5.25
1912	6.50	6.25	6.70	6.40	6.90	6.55	6.75	6.60
1913	7.175	6.60	6.60	6.05	6.25	5.75	5.85	5.40
1914	5.25	5.10	5.35	5.20	5.225	5.125	5.125	4.85

Monthly price range of prime western spelter, 1902–1914—Continued.

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.65	4.40	4.85	4.80	5.35	5.05	5.50	5.35
1903	5.80	5.75	6.25	5.75	6.25	5.87	6.00	5.80
1904	5.22	4.95	4.95	4.75	4.90	4.87	5.07	4.90
1905	5.70	5.40	5.35	5.25	5.60	5.25	5.80	5.60
1906	6.10	5.90	6.20	6.00	6.05	5.97	6.05	6.02
1907	6.60	6.35	6.45	6.35	6.35	5.85	5.90	5.50
1908	4.675	4.55	4.675	4.45	4.70	4.40	4.775	4.65
1909	5.125	4.875	5.325	5.10	5.325	5.175	5.675	5.325
1910	5.175	4.85	5.075	4.925	5.075	4.95	5.275	5.00
1911	5.25	5.20	5.65	5.20	5.70	5.525	6.05	5.675
1912	6.80	6.65	7.00	6.75	7.10	6.95	7.20	6.80
1913	5.40	5.20	5.15	4.95	5.45	5.15	5.80	5.45
1914	5.00	4.90	4.975	4.825	4.95	4.80	6.00	4.70

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	5.50	5.30	5.50	5.40	5.35	5.10	5.00	4.50
1903	6.10	6.00	6.12	6.00	6.00	5.25	5.25	4.65
1904	5.15	5.07	5.37	5.15	5.80	5.37	6.12	5.80
1905	5.95	5.75	6.15	6.00	6.25	6.10	6.60	6.40
1906	6.35	6.05	6.30	6.15	6.45	6.25	6.65	6.45
1907	5.50	5.05	5.55	5.25	5.25	4.50	4.55	4.10
1908	4.825	4.70	4.875	4.75	5.05	4.875	5.15	5.10
1909	5.80	5.55	6.275	5.775	6.275	6.175	6.225	6.00
1910	5.45	5.225	5.725	5.375	5.90	5.70	5.775	5.275
1911	5.95	5.80	6.25	5.825	6.85	6.25	6.80	6.10
1912	7.50	7.20	7.45	7.30	7.375	7.25	7.25	7.15
1913	5.75	5.425	5.45	5.15	5.225	5.05	5.15	4.975
1914	5.85	4.95	5.00	4.60	5.20	4.80	5.65	5.20

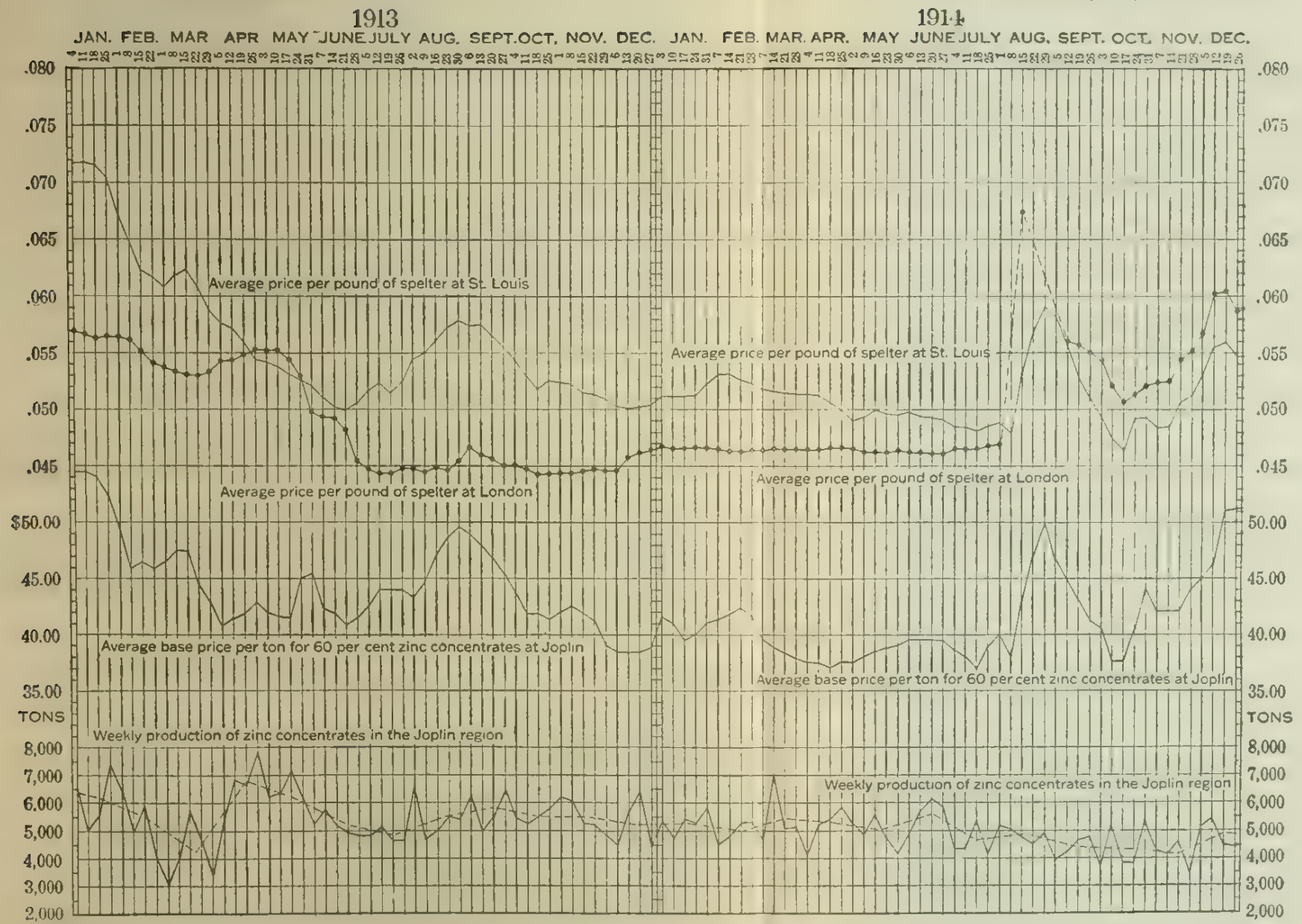
VALUE.

The value of the 343,418 short tons of primary spelter smelted in the United States from domestic ores in 1914, as based on the average St. Louis price, was $35,028,636, compared with an output of 337,252 tons valued at $37,722,224, in 1913, an increase of 6,166 tons, about 2 per cent, in quantity and a decrease of $2,743,588, or 7 per cent, in value.

The following table gives for comparison the quantity and value of the domestic production for the years 1909 to 1914:

Production and value of domestic primary spelter, 1909–1914, in short tons.

Year.	Quantity.	Average price at St. Louis.	Value.
1909	230,225	$0.054	$24,864,300
1910	252,479	.054	27,267,732
1911	271,621	.057	30,964,794
1912	323,907	.069	44,699,166
1913	337,252	.056	37,772,224
1914	343,418	.051	35,028,636



CURVES SHOWING WEEKLY AVERAGE PRICES OF SPELTER AT ST. LOUIS AND LONDON AND OF ZINC CONCENTRATES AT JOPLIN; ALSO WEEKLY PRODUCTION OF ZINC CONCENTRATES IN THE JOPLIN REGION.

PRICE CURVES, 1913–14.

Plate I shows graphically for the years 1913 and 1914, the relations of the weekly average St. Louis price of spelter, the weekly average London price of spelter, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and the weekly production, or, to be more exact, the weekly sales of concentrates in the Joplin region as a whole. The price of spelter has been taken from market reports, and the price of zinc blende and the figures of weekly production are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken line.

The curve of the London prices of spelter from July, 1913, to July, 1914, inclusive, shows a range of not over one-fourth cent, rising from a little more than 4.4 cents at the beginning to a little less than 4.7 at the close, thus illustrating the stabilizing effect of the zinc convention. The St. Louis price on the other hand had during this period a range of 1 cent and declined from 5.8 cents in August, 1913, to 4.8 cents in July, 1914. The war put an end to the zinc convention, and since that time London price of spelter has closely paralleled the price at St. Louis.

GRADES OF PRIMARY SPELTER.

The United States Navy Department has issued the following specifications governing the purchase of slab zinc:

MATERIAL.

Only virgin spelter—that is, spelter made from ore or similar raw material by a process of reduction and distillation and not produced from reworked metal—shall be furnished for grades A, B, and C.

CHEMICAL REQUIREMENTS.

The chemical requirements shall be as follows:

Grade.	Zinc, minimum.	Cadmium, maximum.	Iron, maximum.	Lead, maximum.	Aluminum.	Other elements—Sn., arsenic, S., and Sb., etc.	Sum of cadmium, iron, and lead, maximum.
A	99.85	0.05	0.03	0.07	None	None	0.10
B	99.35	.50	.03	.20	None	Traces only	.50
C	98.60	.75	.04	.75	Traces only	Traces only	1.20
D	98.00	.75	.08	1.50	Traces only	Traces only	2.00

NOTE.—Ten grains of sample tested by Marsh test shall not show more than a perceptible spot of arsenic on a cold porcelain surface.

PURPOSES FOR WHICH USED.

Grade A is suitable for the manufacture of cartridge cases and other high-grade nonferrous alloys, including high tensile manganese bronzes. Grade B is suitable for nonferrous alloys where low lead contents is specified, such as medium quality manganese bronze and gun metal, etc. Grade C is suitable for nonferrous alloys where lead contents of 1 to 3 per cent is specified. Grade D is suitable only for galvanizing purposes.

The four grades, A to D, in the foregoing correspond to the specifications for high-grade, intermediate, brass-special, and prime western grades as adopted by the American Society for Testing Materials. For a résumé of the latter specifications see the chapter on zinc in Mineral Resources for 1912, Part I, page 408.

CANADIAN SPELTER BOUNTY.

In order to encourage the efforts now being made to reduce zinc ores in a commercial way in Canada and to protect the operators from the possibility of disastrous competition after the war, the Canadian Government has established a bounty on spelter made in Canada from Canadian ores.

About the middle of August, 1915, the following information was given to the press in Canada under the authority of the minister of finance, the Hon. W. T. White:

A committee of the Government, under the chairmanship of the minister of finance, after full discussion with members of the shell committee, has satisfactorily solved the problem of insuring at reasonable prices a Canadian supply of zinc suitable for use in the production of brass for the making of quick-firing cartridge cases for shells. Before the outbreak of war this quality of zinc sold at about 8 cents per pound. Since that time the price has steadily risen as high as 40 cents, and grave fears were entertained that the supply might be entirely cut off. At present the sources of supply are outside of Canada. The shell committee, representing the British Government in the purchase of shells in Canada, regarded it as absolutely necessary that there should be supplies of this zinc within Canada. Canadian producers were unwilling to go to the large expense of installing refineries unless insured against the fall in zinc prices, which is inevitable after the close of the war. After considerable negotiation the Government decided to offer a limited bounty for the production in Canada of zinc, the offer being as follows:

Bounties on a sliding scale not exceeding 2 cents per pound will be granted upon production in Canada from Canadian ores of zinc containing not more than 2 per cent impurities when the standard price of zinc in London, England, falls below £33 per ton of 2,000 pounds [8 cents per pound], provided that bounties shall not be payable on zinc produced before the expiration of the war, or after July 31, 1917, or on zinc contracted for by the shell committee at a price of 8 cents or over per pound. Total amount of bounty to be paid not to exceed $400,000. As a result of this action on the part of the Government, the shell committee, on behalf of the Imperial War Office, has been able to contract for several thousand tons of zinc at very reasonable rates, with a further reduced rate for future deliveries. It will be observed that the object of the bounty is to insure the producers against too great a fall in price in the period between the end of the war and July 31, 1917. The bounty will give an impetus to the refinement of zinc in Canada, and serve the purpose of insuring a certain supply of brass to the shell committee.

SURVEY PUBLICATIONS ON LEAD AND ZINC.

The following list includes the more important publications on lead and zinc published by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The publications marked "exhausted" are no longer available for distribution but may be seen at the larger libraries of the country:

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BAIN, H. F., Lead and zinc deposits of Illinois: Bull. 225, pp. 202–207, 1904. Exhausted.
——— Lead and zinc resources of the United States: Bull. 260, pp. 251–273, 1905. Exhausted.
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——— Zinc and lead deposits of northwestern Illinois: Bull. 246, 56 pp., 1905. 15c.
——— Zinc and lead deposits of the upper Mississippi Valley: Bull. 294, 155 pp., 1906. 75c.
——— Zinc and lead ores in 1905: Mineral Resources, 1905, pp. 379–392, 1906. $1.
BAIN, H. F., VAN HISE, C. R., and ADAMS, G. I., Preliminary report on the lead and zinc deposits of the Ozark region: Twenty-second Ann. Rept., pt. 2, pp. 23–228, 1901. $2.25.
BANCROFT, HOWLAND, Reconnaissance of the ore deposits in northern Yuma County, Ariz.: Bull. 451, 130 pp., 1911.
——— Lead and zinc deposits in the Metaline mining district, northeastern Washington: Bull. 470, pp. 188–200, 1911.
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BROOKS, A. H., Geologic features of Alaskan metalliferous lodes: Bull. 480, pp. 43–93, 1911.
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CALKINS, F. C., and JONES, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. 540, pp. 167–211, 1914.
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CLERC, F. L., The mining and metallurgy of lead and zinc in the United States: Mineral Resources, 1882, pp. 358–386, 1883. 50c.
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CURTIS, J. S., Silver-lead deposits of Eureka, Nev.: Mon. 7, 200 pp., 1884. $1.20.
ELLIS, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, pp. 311–315, 1905. Exhausted.
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——— Abstract of report on geology and mining district of Leadville, Lake County, Colo.: Second Ann. Rept., pp. 201–290, 1882. $2.
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[1] Earlier volumes of the Mineral Resources of the United States also contain discussions relating to the lead and zinc industries of the United States.

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HAHN, O. H., The smelting of argentiferous lead ores in the far West: Mineral Resources, 1882, pp. 324–345, 1883. 50c.
HILL, J. M., Mining districts of the western United States: Bull. 507, 309 pp., 1912.
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HUNTER, J. F., Some cerusite deposits in Custer County, Colo.: Bull. 580, pp. 25–37, 1914.
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——— and GARREY, G. H., Preliminary report on the ore deposits of the Georgetown mining district, Colorado: Bull. 260, pp. 99–120, 1905. Exhausted.
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——— Geol. Atlas, Little Belt Mountains folio (No. 56), 1899. 5c.
——— Geology of the Little Belt Mountains, Montana, with notes on the mineral deposits of the Neihart, Barker, Yogo, and other districts: Twentieth Ann. Rept., pt. 3, pp. 271–461, 1900. $1.50.
WEED, W. H., and BARRELL, JOSEPH, Geology and ore deposits of the Elkhorn mining district, Jefferson County, Mont.: Twenty-second Ann. Rept., pt. 2, pp. 399–549, 1901. $2.25.
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WINSLOW, A., The disseminated lead ores of southeastern Missouri: Bull. 132, 31 pp., 1896. 5c.
WOLFF, J. E., Zinc and manganese deposits of Franklin Furnace, N. J.: Bull. 213, pp. 214–217, 1903. 25c.

CADMIUM.

By C. E. Siebenthal.

PRODUCTION.

A brief account of the production, resources, metallurgy, and uses of cadmium was given as a chapter in Mineral Resources for 1908, Part I, and the reader is referred to that paper for further information.

The chief output of cadmium comes from the zinc-producing regions of Silesia, where it is recovered as a by-product in the distillation of zinc. No cadmium is recovered in the United States in the distillation of zinc ores, but most of the output is gained from bag-house fumes of lead smelters which treat lead ores containing more or less zinc. In England a little cadmium is recovered in the purification of the solution of zinc sulphate in the manufacture of lithopone, and some has been recovered in the same way in the United States for several years. Another source of cadmium is the residues left after the manufacture of zinc chloride from low-grade zinc ores and from zinc ashes and drosses.

The cadmium output of the United States comes in two forms, metallic stick cadmium, and the pigment cadimum sulphide, "cadmium-yellow." Inasmuch as the production in these forms is limited to two firms, the quantity and value of the output can not be given. The local production in 1907 was nearly sufficient to supply the domestic demand—a fact shown by the small imports for that year—but the next year the quantity of cadmium imported was about doubled, and in 1909–1912 the imports of cadmium were back at the old figures which obtained before the beginning of the production of cadmium in the United States. The domestic production was considerably larger in 1913–14, than in any previous years and as a result the imports of cadmium were the smallest since 1903.

IMPORTS.

Cadmium is imported into the United States as metallic stick cadmium and as the pigment, cadmium sulphide. The former is free of duty; the latter is dutiable at 30 per cent ad valorem. The value of the imports for consumption of metallic cadmium for 1903 to 1913, inclusive, is given in the table below, which is taken from the records of the Bureau of Foreign and Domestic Commerce. The quantities are not there recorded previous to July, 1909, and for the period preceding that time they have been computed by dividing the values of the imports by the average price of cadmium for the

corresponding year in Germany, from which country the cadmium was imported. The quantity and value of cadmium imported as a pigment are not kept separately by the Bureau of Foriegn and Domestic Commerce.

Cadmium imported for consumption into the United States, 1903–1914, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	[a] 8,679	$4,565	1909 first half	[a] 6,659	$4,559
1904	[a] 7,655	4,524	1909 second half	2,203	
1905	[a] 8,138	5,298	1910	4,060	2,295
1906	[a] 13,808	10,522	1911	5,367	3,870
1907	[a] 1,953	1,633	1912	5,250	3,764
1908	[a] 3,567	2,390	1913	1,656	1,232
			1914	441	368

[a] Prior to July, 1909, the quantities are computed as noted above.

PRICES.

The price of metallic cadmium in sticks throughout the first seven months of the year varied from 85 to 95 cents per pound. With the commencement of the war retail prices in small lots rose to $1.15 per pound and during the last quarter of the year some sales were made at $1.35 per pound. The average price per pound as based on sales was about 90 cents.

COBALT.

By Frank L. Hess.

PRODUCTION.

No cobalt is known to have been produced from domestic ores in 1914. Elwood Haynes, the inventor of stellite, an alloy of cobalt, chromium, and other metals,[1] reduced the cobalt he used in making stellite from cobalt oxide derived from Canadian ores. Most if not all of the cobalt used by steel manufacturers is thought to have been imported. The American localities at which cobalt may possibly be obtained and the uses of cobalt have already been noted in Mineral Resources.[2]

IMPORTS.

The imports for consumption of cobalt oxide, cobalt ore, and zaffer (an impure oxide of cobalt) since 1906, as shown by statistics compiled by the Bureau of Foreign and Domestic Commerce, are given below:

Cobalt oxide, cobalt ore, and zaffer imported into the United States for consumption, 1906–1914, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906	41,084	$83,167	1911	602,454	$59,151
1907	48,013	74,849	1912	791,242	83,080
1908	219,098	17,677	1913	209,396	95,735
1909	12,132	11,096	1914	334,556	274,538
1910	14,935	6,352			

No record is kept of the imports of metallic cobalt. The price of the metal seems to have varied little during the last three years, ranging from $1.50 to $2 a pound.

TESTS.

The commonest cobalt minerals—linnæite, Co_3S_4, generally containing also some nickel and iron; smaltite, $CoAs_2$; cobaltite, CoAsS; and erythrite, $Co_3(AsO_4).8H_2O$—may be easily tested by heating a fragment of the mineral in a bead of borax or of salt of phosphorus before the blowpipe. A very small quantity of cobalt will

[1] U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 965, 995, 1913.
[2] Idem, pp. 963–968.

give a beautiful blue color to either bead, even in the presence of considerable quantities of copper, iron, and nickel. If copper and nickel interfere the bead may be heated on charcoal in the reducing flame with a granule of tin, thus reducing the nickel and copper to the metallic state, after which the flux will show the blue cobalt color. Iron, when in quantity sufficient to interfere, must be removed by solution and precipitation.

Linnæite, smaltite, and cobaltite are silvery-looking minerals not easily distinguishable from some other metallic minerals until they become well known, but erythrite has a beautiful and very characteristic peach-blossom color.

MOLYBDENUM.

By Frank L. Hess.

PRODUCTION AND PRICES.

The production of molybdenum minerals in the United States has never been large, but the demands of buyers in 1914 were more insistent than before, and although the production was still comparatively small, the interest in molybdenum mining was much greater.

Some molybdenite, molybdenum sulphide, MoS_2, was mined and shipped by the Aurelia Crown Mines Co. from its mines west of Lake Chelan, Wash., and by Margarito Romero of Las Vegas, N. Mex. Henry E. Wood & Co. concentrated molybdenite ores from British Columbia at their Denver plant. The dumps of the Mammoth mine, at Mammoth, Ariz., were worked by Hereford and Boykin, Francis Hagerman & Co., and the Arizona Rare Metals Co. in turn for the wulfenite, lead molybdate, $PbMoO_4$, which they contained, and some shipments were made. Ralph Widener mined wulfenite from the Gladys claim, in the Caballos Mountains, near Cutter, N. Mex. Near the end of the year preparations were made by the Primos Chemical Co. near Empire, Colo., to mine molybdenite in a larger way than it has yet been mined in this country.

The price of molybdenite reached $2 a pound for choice hand-picked material that probably carried more than 90 per cent MoS_2. Poorer material sold at half the price. Wulfenite seems to have sold at 50 to 60 cents a pound for the molybdenum oxide it contained. Marketable wulfenite ores should carry at least 25 per cent molybdenum oxide and be free from copper, vanadium, tungsten, and chromium. It is difficult to find ores free from all these impurities.

USES.

Molybdenum is used principally in making "high speed" steels. Ammonium molybdate is used as a chemical reagent; metallic molybdenum is used in resistance furnaces, as supports for filaments in electric incandescent lamps, as parts of Roentgen ray tubes and possibly in other electrical appliances, and also as one of the alloying metals in stellite. Reports are current that ammonium molybdate is used as a preservative of certain forms of smokeless powder in hot climates, but these reports can not be confirmed. The use of molybdenum in high-speed steels seems to account for the great rise in its price—from 20 or 30 cents a pound in 1912 to $2 a pound in 1914. When a sudden demand was created there was no corresponding increase in supply.

TESTS FOR MOLYBDENUM.

In identifying minerals a knowledge of their characteristics may be as valuable as chemical tests. A short description of molybdenum minerals is therefore given.

Three molybdenum minerals are fairly common—molybdenite, wulfenite, and molybdenum ocher. Molybdenite, molybdenum sulphide, MoS_2, containing 60 per cent molybdenum, occurs in thin, bright, lead-colored flakes, which bend readily but are not elastic and are easily scratched by the finger nail. The flakes may be so minute that they coat a surface like paint, or they may be several inches across, and they may be regularly bounded by straight lines and piled up into doubly terminated hexagonal crystals. The mineral, however, is more likely to be found in irregular lumps, easily cleavable into thin leaves. Its specific gravity is about 4.5.

Molybdenite is associated with many kinds of rocks and veins but occurs most plentifully in association with granitic rocks, especially with granite pegmatites. The deposits are invariably pockety.

Wulfenite, lead molybdate, $PbMoO_4$, contains 39.3 per cent MoO_3. It usually occurs as lustrous resinous yellow, orange, or red tetragonal crystals in the oxidized parts of lead deposits. It may be greenish or brownish, grayish, whitish, or colorless. The crystals are generally platy, but may be nearly cubes or double pyramids. The mineral is very brittle. It has a hardness of 2.75 to 3 and a specific gravity of 6.7 to 7.

Molybdenum ocher, hydrous ferric molybdate, $Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$, generally forms a bright yellow powdery mineral, though it also appears in small radial crystals. It is a weathering product of molybdenite, but is probably never found in sufficient quantity to be of commercial value.

Powellite, calcium molybdate, $CaMoO_4$, is a white or grayish mineral formed by the weathering of molybdenite. In some specimens tungsten replaces a part of the molybdenum. Like molybdenum ocher, it is not found in deposits of sufficient size to be of commercial value.

Any of these minerals except molybdenite may be tested by heating a small piece in a porcelain crucible (a particle half the size of a grain of wheat is enough) with a drop of sulphuric acid until the fumes have nearly ceased. When the crucible has cooled, it will have a beautiful deep blue coating.

Molybdenite must be oxidized before it can be tested in this manner. It may be oxidized either by boiling it to dryness with two or three drops of nitric acid or by powdering and roasting it in the air for a few minutes. The sulphuric acid is then added and the test performed as indicated.

NICKEL.

By Frank L. Hess.

PRODUCTION.

No nickel ores are known to have been mined as such in the United States in 1914, but an equivalent of 845,334 pounds of metallic nickel, valued at $313,000, is understood to have been saved as a by-product in the electrolytic refining of copper. A part of this nickel was marketed in the form of sulphate and a part as electrolytically deposited metal.

It is impossible to tell how much of this nickel was derived from copper ores of domestic production and how much from foreign ores, but a considerable part—possibly one-third to one-half—was produced from domestic ore.

Nickel has been reported in various blister coppers in pounds per hundred tons as follows: Anaconda, Mont.,[1] 22; Great Falls, Mont.,[1] 68; Garfield, Utah, 40; Steptoe, Nev., 64; Omaha, Nebr., 944; Mountain, Cal., 172; Tacoma, Wash., 770; Aguascalientes, Mexico, 132; Cerro de Pasco, Peru, 32; Mount Lyell, Tasmania, 166.

In electrolytic refining nickel collects in the electrolyte, from which it is obtained.

During the year the price of nickel ranged from about 35 cents to 45 cents a pound.

IMPORTS.

As usual, the great bulk of the nickel imported was matte from the International Nickel Co.'s smelter at Copper Cliff, Ontario, the ores coming from their mines at Sudbury. The matte is refined at Bayonne, N. J. A much smaller quantity of rich matte was imported from Belgium, whither it had come as lower grade matte from New Caledonia. The rich matte is refined at New Brunswick, N. J., by the United States Nickel Co.

The imports of nickel for consumption into the United States for several years, as reported by the division of statistics, Bureau of Foreign and Domestic Commerce, have been as follows:

[1] Letter from F. L. Antisell. The quantities were given as percentages, viz, Anaconda, 0.011; Great Falls, 0.034. The other figures are quoted from A. Eilers, Notes on the occurrence of some of the rarer metals in blister copper: Am. Inst. Min. Eng. Trans., vol. 47, p. 217, 1914. All figures except the first two are quoted from Eilers.

Imports of nickel for consumption into the United States, 1910–1914, in pounds.

Year.	Nickel, nickel ore and matte, nickel oxide, alloys of nickel with copper, etc.[a]		Value of manufactured articles of nickel.	Total value.
	Quantity.	Value.		
1910	32,363,251	$4,213,079	$14,759	$4,227,838
1911	29,829,268	4,022,716	27,314	4,050,030
1912	46,317,078	5,724,431	34,536	5,758,967
1913	47,446,520	6,562,555	38,200	6,600,755
1914	35,098,958	5,000,594	28,224	5,028,818

[a] Includes only the nickel content of ore and matte. No ore is known to have been imported into the United States in 1911, 1912, or 1913.

The imports in 1914 were divided into the groups indicated below.

Forms of nickel imported for consumption into the United States in 1914, in pounds.

Form.	Quantity.	Value.
Nickel, alloys, pig, bars, etc	106,019	$42,678
Ore and matte (nickel content)	34,989,745	4,956,448
Nickel oxide	3,194	1,468
Total	35,098,958	5,000,594

EXPORTS.

The United States refines much more nickel than it can use, so that, though not a large producer, it is a large exporter. The exports since 1910 have been as follows:

Exports of nickel, nickel oxide, and matte,[a] from the United States, 1910–1914, in pounds.

Years.	Quantity.	Value.
1910	15,244,937	$4,704,088
1911	25,099,586	8,283,777
1912	25,815,016	8,515,332
1913	29,173,088	9,686,794
1914	27,595,152	9,455,528

[a] No nickel matte is known to have been exported in the years 1911 to 1914, inclusive.

CANADIAN PRODUCTION.

The United States depends so largely on Canada for its supply of nickel that the conditions in the Canadian nickel industry are of great interest here. The following quotations from a Canadian report [1] are therefore of high practical value.

The declaration of war resulted in the almost immediate closing down of a considerable portion of the mining and smelting operations of the Canadian Copper Co.

[1] McLeish, John, Preliminary report on the mineral production of Canada during the calendar year 1914: Canada Dept. Mines, Mines Branch, pp. 13–15.

in the Sudbury district, and although they were partially resumed before the close of the year the company's output was greatly reduced. The Mond Nickel Co., on the other hand, having increased the capacity of its smelter at Coniston, nearly doubled its output. Ores from the Alexo nickel mine, north of Cobalt, were also reduced in this smelter. Ten separate properties were worked by these companies.

The nickel-copper ore is reduced in smelters and converters to a Bessemer matte containing from 77 to 82 per cent of the combined metals and shipped in that form to Great Britain and the United States for refining, the product of the Canadian Copper Co. going to New Jersey and that of the Mond Nickel Co. to Wales. A portion of the matte produced by the Canadian Copper Co. is used for the direct production of Monel metal, an alloy of nickel and copper, without the intermediate refining of either metal.

The total production of matte in 1914 was 46,396 tons, valued by the producers at the smelters at $7,189,031, and containing 28,895,825 pounds of copper and 45,517,937 pounds of nickel. The tonnage of ore smelted (part being previously roasted) was 947,053. The production in 1913 was 47,150 tons of matte, containing 25,875,546 pounds of copper and 49,676,772 pounds of nickel, showing an increase in 1914 in copper content and a falling off in nickel.

There is also a small recovery of nickel in the form of nickel oxide from the Cobalt district ores, the production in 1914 being reported as 391,312 pounds of oxide, valued at $26,483.

The aggregate results of the smelting operations on nickel-copper ores during the past five years and the exports of nickel are shown in tabular form [below].

* * * A much larger quantity of nickel finds its way to the United Kingdom through United States refineries than is exported directly from Canada.

Production of nickel in Canada, 1911–1914, in short tons.

Form of product.	1911	1912	1913	1914
Ore mined	612,511	737,584	784,697	1,000,364
Ore smelted	610,834	725,065	823,403	947,053
Bessemer matte produced	32,607	41,925	47,150	46,396
Copper content of matte	8,966	11,116	12,938	14,448
Nickel content of matte	17,049	22,421	24,838	22,759
Spot value of matte	$4,945,592	$6,303,102	$7,076,945	$7,189,031

Exports from Canada of nickel contained in matte, etc., 1911–1914, in pounds.

Destination.	1911	1912	1913	1914
Great Britain	5,023,393	5,072,867	5,164,512	10,291,979
United States	27,596,578	39,148,993	44,224,119	36,015,642
Other countries	.....	.....	70,386	220,706
	32,619,971	44,221,860	49,459,017	46,538,327

TEST FOR NICKEL.

The following directions for a test for nickel have been prepared by W. C. Wheeler:

Grind to a fine powder a sample—2 or 3 grams (30 to 40 grains); treat in a test tube with a few cubic centimeters of aqua regia (a mixture of 1 part nitric acid and 3 or 4 parts of hydrochloric acid), and boil nearly to dryness; then add enough nitric acid and water to dissolve all soluble substances. Filter if necessary. Dilute to 10–15 cubic centimeters (about one-third the contents of a test tube 6 inches long and three-fourths of an inch in diameter), add a gram or more (half a teaspoonful) of citric acid (solid), and dissolve by

heating. Make the solution slightly ammoniacal, noting that it should contain no precipitate. To the slightly ammoniacal solution add about 2 cubic centimeters (a half teaspoonful) of 1 per cent alcoholic solution of dimethylglyoxime. A voluminous scarlet precipitate indicates nickel.

The aqua regia solution is boiled nearly to dryness to remove from it the large excess of acid and anything, such as hydrogen sulphide, that would cause the precipitation of iron, cobalt, nickel, etc., in the ammoniacal solution.

The citric acid will prevent the precipitation of iron and aluminum as hydroxides, but will not prevent the precipitation of sulphides of iron, cobalt, nickel, and some other metals in the ammoniacal solution.

If a brown precipitate of iron forms after the solution is made ammoniacal, it contains an insufficient quantity of citric acid.

TIN.

By Frank L. Hess.

PRODUCTION.

The only domestic production of tin in 1914 was made in Alaska, and except a small quantity produced from the lodes on Lost River, was stream tin. The dredge of the York Dredging Co. on Buck Creek was again in operation, and the American Gold Dredging Co., on Anikovik River, a few miles away, started two small dredges to work for both gold and stream tin. One of the dredges was towed from Peluk Creek, Nome, along the coast to Bering Sea and cut its way through the bar into the mouth of Anikovik River, where it was held for remodeling. The other dredge, which was new, was erected in an artificial pond a quarter of a mile from the beach. It was completed August 1 and operated continuously until it was frozen up—about 65 days. The principal metal mined is gold, but some tin was obtained.[1]

The Jamme Syndicate [2] carried on experimental and exploratory work on the tin lodes along Lost River. The syndicate milled 79 tons of ore, which yielded 6,250 pounds of concentrates carrying 62 per cent tin and 11 per cent tungsten. The concentrates were smelted in Seattle by the syndicate, which also smelted a few tons of the Buck Creek stream tin. Mr. Jamme reports that the Buck Creek concentrates carried $6.03 per ton in gold, of which he was able to save $5.70 without loss of tin. Most of the Buck Creek material was shipped to Singapore, Federated Malay States.

At Tofty, in the Hot Springs district, stream tin is saved in connection with sluicing for gold. Tofty is a short distance south of Tanana River near the point where it is crossed by the 151st meridian west of Greenwich. At first the pebbles of cassiterite were considered a nuisance, but later it was found that it would pay to save them as tin ore. Forty-eight tons of the ore were shipped from the district in 1914.

The gold-tin placers are on Sullivan Creek. The general placer zone is about half a mile wide and about 6 miles long, extending from Upper Cache Creek to Woodchopper Creek. Within this zone there are numerous small areas of concentration.[3]

The tin ore produced in Alaska in 1914 amounted to 157.5 tons of concentrates carrying 104 tons of tin, and was worth $66,560. The only tin ore known to have been produced in the United States proper was a few hundred pounds of stream tin, which was taken out on Bear Creek near Tinton, S. Dak.

[1] Eakin, H. M., Tin mining in Alaska: U. S. Geol. Survey Bull. 622, pp. 91-92, 1915.
[2] Letter of George Jamme dated Dec. 1, 1914.
[3] Eakin, H. M., op. cit., p. 93.

IMPORTS.

The United States is the greatest user of tin among the nations, and the imports are of course large. A very large part of the tin imported comes by way of England and Holland from the Malay Federated States and the Dutch East Indies, though at least one American company finds it advantageous to keep a buyer in the Far East to avoid payment of European profits, charges for extra shipping and handling, and possibly excessive prices due to manipulation of the market.

The imports of metallic tin for consumption during the last nine years are shown below. The figures do not include the tin contained in imported ore, tin foil, or other manufactures.

Tin imported and entered for consumption in the United States, 1906–1914.

Year.	Quantity.	Value.
	Short tons.	
1906	50,477	$37,447,315
1907	41,257	32,074,263
1908	41,267	23,923,560
1909	47,662	27,558,546
1910	52,528	33,913,255
1911	53,527	43,346,394
1912	58,016	50,372,478
1913	[a] 53,315	46,946,756
1914	[b] 52,919	32,943,059

[a] Includes 986 tons of "scrap tin," valued at $19,543.
[b] Includes 5,389 tons of "scrap tin," valued at $61,440.

WORLD'S PRODUCTION OF TIN.

The world's annual production of tin is about equal to the quantity delivered to the market. Though more or less time elapses between the delivery of tin ore to smelters and the placing of the metal on the market, so that the ore produced in the last months of the year does not supply marketable tin until the following year, this delay is fairly well equalized by tin delivered to the market in the first part of the year from ores delivered to the smelters during the previous year.

The world's output of tin since 1910, as compiled by C. Mayer, secretary of the New York Metal Exchange, has been as follows:

World's production of tin, 1911–1914, in short tons.[a]

Item.	1911	1912	1913	1914
London deliveries	17,643	20,823	20,045	23,335
Continent of Europe	24,671	29,820	28,707	22,747
Cornwall (production)	5,936	6,160	6,496	6,720
Bolivia (shipments)	25,312	23,744	27,832	21,000
South Africa (shipments)	3,248	3,472	3,584	5,600
China (shipments)	1,680	2,576	2,744	2,128
United States (receipts)	51,892	57,557	51,017	48,505
Total	130,382	144,152	140,425	130,035
Deductions of Straits, etc., from Continent and English, Bolivian, etc., arriving in the United States	6,832	9,598	10,416	9,635
Total	123,550	134,554	130,009	120,400

[a] Statistical review of the domestic and foreign markets for the various years.

These figures are published soon after the close of the year and are therefore only approximate.

Mr. Mayer's figures on the origin of supplies in 1914 are:

Supplies of tin in 1914, in tons of 2,000 pounds.

	Short tons.
Straits Settlements, shipments	70,560
Australia, shipments	2,016
Bolivia, shipments	21,000
South Africa, shipments	5,600
China, shipments	2,128
Banka, sales in Holland	10,416
Billiton, sales in Java	1,400
Cornwall, production	6,720
Total	119,840

PRICES.

The prices of Straits tin in New York for several years are shown below.

Average monthly prices, in cents per pound, of Straits tin in New York from 1909 to 1914.

Month.	1909	1910	1911	1912	1913	1914 [a]
January	28.13	32.74	41.39	43.24	50.425	37.74
February	28.30	32.96	42.83	43.46	48.63	39.93
March	28.74	32.49	40.76	42.86	46.835	38.08
April	29.48	33.02	42.20	44.02	49.12	36.10
May	29.16	33.18	43.10	46.12	49.07	33.30
June	29.32	32.84	46.16	47.77	44.82	30.65
July	29.17	33.04	42.96	44.75	40.27	31.75
August	30.04	34.10	43.45	45.87	41.668	50.595
September	30.35	35.23	39.98	49.18	42.375	32.79
October	30.50	36.63	41.21	50.11	40.41	30.395
November	30.90	36.68	43.13	49.90	39.805	33.50
December	33.06	38.28	44.97	49.90	37.62	33.60
Average	29.76	34.27	42.68	46.43	44.225	35.70

[a] Metal statistics, 1915, p. 225.

TESTS FOR CASSITERITE.

The simplest and easiest test for cassiterite is to place a fragment of the mineral in dilute hydrochloric or sulphuric acid with granulated, shot, or sheet zinc. The zinc and the acid rapidly evolve hydrogen, which takes the oxygen from the mineral and leaves a coating of tin on the fragment tested. Granulated zinc is the best to use, as its small particles can be made to touch the specimens at many points and thus bring more of the hydrogen in contact with the molecules of tin-oxide. The reaction is $4H + SnO_2 = Sn + 2H_2O$.

The metallic coating has a dull gray, somewhat leaden appearance, but it may be made lustrous by rubbing with a soft cloth or with the hand. If the hand is used, the characteristic odor given off when tin is rubbed on the flesh may be noted.

This simple and efficient method may be used on crystals or choice specimens without injury to them. The smooth surface of stream-polished wood tin is, however, roughened by this test, owing to the impurities in the mineral, though the surface of ordinary crystalline

cassiterite is not noticeably affected. After the test has been made, the coating of metallic tin can be removed by immersing the piece in dilute hydrochloric, sulphuric, or nitric acid.

The blowpipe test is better known and is more often used, though it is not made so readily. The mineral supposed to be cassiterite is pulverized and should yield a light-colored powder unless it is mixed with iron oxides, in which case the powder will be reddish or brown. Some cassiterites from the Carolinas and South Dakota, however, give a purplish powder. A small portion of the powder is mixed with twice its bulk of pulverized charcoal and three times its bulk of sodium carbonate or bicarbonate (ordinary washing or baking soda). The three substances are thoroughly mixed, and a portion the size of a pea is moistened and placed in a hollow in a piece of charcoal. By means of a reducing blowpipe flame tin is readily reduced in small globules, which are easily distinguished from the flux. When cooled the metallic globules may be separated from the soda and will be malleable. If large enough they will emit the characteristic disagreeable odor when rubbed between the fingers and will yield a white precipitate when treated with concentrated nitric acid. They are soluble in hydrochloric acid, and no precipitate is formed when the solution is cold. These reactions with acids differentiate the metal from lead.

TITANIUM.

By Frank L. Hess.

PRODUCTION.

Titanium is obtained from two minerals—rutile, titanium dioxide, TiO_2, and ilmenite, iron titanium oxide, $FeTiO_3$.

The only rutile produced in the United States in 1914, so far as known to the United States Geological Survey, was, as heretofore, that put out by the American Rutile Co. at Roseland, Nelson County, Va. The company produced 94 tons of rutile carrying 95 per cent of titanium dioxide and, as a by-product, 89 tons of ilmenite, carrying about 55 per cent of titanium dioxide. The sales included a quantity of rutile left over from 1913 equal to the production of 1914. The company did not operate its mill in 1914 until the middle of August. During the earlier part of the year the mill was thoroughly overhauled and new stamps and other machinery were installed. It is stated that large foreign orders could not be filled on account of the effect of the war upon commerce.

The rutile-bearing rock, which Dr. T. L. Watson, State geologist of Virginia, calls syenite, but which shows decidedly pegmatitic phases, is worked in open cuts by the company. Most of the rock worked came from a bluff near the mill, on the east side of Tye River, but some rock was also taken from the west side of the river. The rutile forms about 5 per cent of the rock worked.

At Magnet Cove, Ark., the various forms of titanium dioxide (rutile, octahedrite, and brookite) occur with nepheline syenite. Considerable prospecting has been done on the deposits but no titanium is known to have been produced.

Concentrated rutile sells for $50 to $400 a ton, its price depending on its purity, its form, whether crushed or pulverized, and the quantities purchased.

A little ilmenite has been used in making ferrotitanium, but no figures showing the quantity consumed are at hand. Ilmenite is used also in electrodes for arc lamps.

Rutile is used in electrodes for arc lamps, for making ferrotitanium for use in cast iron and steel, in ceramics, in chemicals (the principal of which is titanium potassium oxalate), and in dyeing leather and wool. Some cuprotitanium for use in copper, brass, and bronze castings has been manufactured.

TESTS FOR TITANIUM MINERALS.

Rutile, octahedrite (anatase), and brookite, all titanium dioxide, TiO_2, are ordinarily glassy and range in color from light brownish yellow or honey-yellow through tints of brown and reddish brown to nearly black. Their streaks are colorless, and their luster is semimetallic. Ilmenite, iron titanium oxide, $FeTiO_3$, gives a dark brown to black streak.

The easiest test for titanium is to powder and fuse the mineral with sodium carbonate, dissolve in dilute sulphuric acid, and add hydrogen peroxide, H_2O_2. If the solution contains titanium it immediately turns reddish yellow to deep amber, the color assumed depending on the quantity of titanium present.

Another test, which is not so delicate or so satisfactory, is to fuse the mineral with a quantity of sodium carbonate equal to about 6 times its volume, dissolve in strong hydrochloric acid, add a little pure tin, and boil. If the solution contains titanium it will assume a delicate violet color.

TUNGSTEN.

By Frank L. Hess.

PRODUCTION.

Later figures have not changed the preliminary estimate of the production of tungsten in 1914 published by the Survey early in 1915. The returns received from the several producers indicate that an equivalent of 990 tons [1] of concentrates carrying 60 per cent of tungsten trioxide, WO_3, valued at $435,000, was mined and sold in 1914. This was a reduction of 547 tons in quantity and of about $237,000 in value from 1913, when 1,537 tons, valued at $672,118, was produced. Another notable feature of the year was that the production of the Atolia field, in the Mohave Desert, Cal., exceeded that of Boulder County, Colo., for the first time. The production in Boulder County amounted to 467 tons. In 1913 the output of Boulder County was 953 tons, a quantity almost equal to that of the whole country in 1914.

Of the various tungsten minerals, the one produced in largest quantity was scheelite from the Atolia district, California. A little scheelite was mined also in the Deep Creek Mountains, Utah. Small quantities of both wolframite and hübnerite were shipped from Arizona, and hübnerite was produced on Patterson Creek, in the Blue Wing district, Idaho. Some wolframite was produced near Penasco, N. Mex., and in the Clark Mountain district, near Ivanpah, Cal.

The production of tungsten ore in the United States has been recorded only since 1900; before that time it was insignificant. The figures obtained by the United States Geological Survey are given below.

Production of concentrated tungsten ores in the United States, 1900–1913, in short tons.[a]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	46	$11,040	1908	671	229,955
1901	179	27,720	1909	1,619	614,370
1902	181	34,040	1910	1,821	832,992
1903	292	43,639	1911	1,139	407,985
1904	740	184,000	1912	1,330	502,158
1905	803	268,676	1913	1,537	672,118
1906	928	348,867	1914	990	435,000
1907	1,640	890,048			

[a] The production of tungsten ores in this country from year to year can be fairly compared in this table only since and beginning with 1906, as before that date no effort was made to reduce the ores to a common basis of concentration. Since 1906 the ores have been, as far as possible, reduced to an equivalent of ore carrying 60 per cent tungsten trioxide, WO_3, which is the ordinary commercial basis in the United States.

[1] The short ton of 2,000 pounds is used throughout this article.

PRICES.

During the earlier part of the year prices were low, about $6.50 per unit (a unit is 1 per cent of a ton in tungsten trioxide), and as most of the known easily mined surface ores had been extracted, such a price offered slight inducement to the miner, so that the year's production was very low. The breaking out of the European war nearly paralyzed tungsten mining for a little while, but toward the end of the year the demand began to quicken, offers of $9 a unit were made, and inquiries for ore became more insistent. But throughout the year prices depended on quality and quantity of ore and the urgency of the needs of buyers and sellers.

WORLD'S PRODUCTION OF TUNGSTEN.

Economic conditions were so greatly disturbed by the European war that it is very difficult to obtain figures showing the tungsten produced in several countries for years later than 1912. Authorities not given in notes below the table were quoted in Mineral Resources for 1913 and preceding years.

The world's production of tungsten ore, 1905–1913, by countries, estimated as far as possible in short tons of concentrates containing 60 per cent of tungsten trioxide.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
Africa: South Africa	.....	9	211	40	16	(a)	(a)	(a)	(a)	(a)
Asia:										
Burma and the Shan States	.....	.....	.....	.....	.....	407	1,119	2,095	1,905	[b]2,055
Federated Malay States	.....	151	89	83	99	105	[c]205	275	273	[c]317
French Indo-China (Tonkin)	.....	.....	.....	.....	.....	19	.....	81	.....	.....
India (not including Burma)	.....	.....	.....	.....	7	23	.....	.....	(a)	.....
Japan	47	47	71	220	292	275	287	225	327	[d]226
Siam	.....	.....	10	.....	.....	.....	200	200	1	[e]33
Trengganu (Malay Peninsula)	.....	.....	.....	.....	.....	.....	.....	.....	.....	[f]173
Australia:										
New South Wales	251	270	451	269	431	413	512	298	220	.....
Northern Territory	71	230	177	40	49	78	71	[g]44	.....	.....
Queensland	1,582	865	703	516	679	1,145	750	944	587	[h]442
Tasmania	36	22	46	5	20	75	86	87	89	.....
Victoria	.....	.....	.....	3	15	31	33	[i]13	[j]1	.....
Western Australia	.....	1	5	.....	1	2	12	(a)	1	[k]1
East Indies:										
Billiton	.....	.....	4	11	12	21	.....	21	.....	.....
Singkep	.....	.....	1	14	12	12	.....	8	.....	.....
Europe:										
Austria	65	63	50	44	43	54	50	73	.....	.....
England	193	304	361	261	421	307	298	216	204	[l]230
France	28	20	67	124	55	33	188	252	.....	.....
German Empire (Saxony)	42	57	68	46	106	105	89	111	.....	.....
Italy	36	28	18	.....	.....	(a)	(a)	(a)	.....	.....
Portugal	320	629	702	684	609	1,132	1,078	1,466	[m]900	.....
Spain	413	222	303	249	142	169	106	202	179	.....
Oceania: New Zealand	64	121	153	87	78	187	184	181	297	[n]274
North America:										
Nova Scotia	.....	.....	.....	.....	.....	83	(a)	17	[o]12	(a)
United States	803	928	1,640	671	1,619	1,821	1,139	1,330	1,537	990
South America:										
Argentina	.....	326	507	548	900	826	683	702	591	[p]435
Bolivia	75	75	500	187	168	232	370	547	328	[q]320
Brazil	.....	.....	.....	16	(a)	(a)	(a)	(a)	(a)	.....
Peru	.....	.....	.....	.....	.....	15	57	241	[r]327	[s]130
Total	4,026	4,367	6,137	4,113	5,774	7,570	7,517	9,654	.....	.....

[a] No tungsten ore produced, so far as can be learned.

[b] Min. Jour. [London], vol. 13, p. 275, 1915, Tavoy, Burma, correspondence. The figures given are 1,631 long tons. The Tavoy concentrates are wolframite of high grade and are taken as averaging 67.5 per cent WO_3. Probably a considerable quantity of tungsten ore that is mixed with cassiterite and

If the countries from which statistics are unavailable produced quantities about equal to those produced during the last year for which their statistics are available the world's production for 1914 was about 7,650 tons.

PROPERTIES AND USES OF TUNGSTEN.

The Survey receives many letters of inquiry about tungsten and its uses, so the following notes may be of general interest.

Tungsten, like iron, copper, zinc, or silver, is a metal. It has a very high specific gravity or density, which ranges from 19.3 to 20.2,

shipped to the Federated Malay States for treatment is not included in the statistics. See Min. Jour. [London], June 12, p. 419, 1915.

c Federated Malay States Gov. Gaz., vol. 7, Jan. 12, 1915. The following figures are given:

Output of wolframite in Federated Malay States in 1913 and 1914.

[In piculs of 133⅓ pounds.]

	1913	1914
Perak	891.95	609.32
Selangor	1,917.98	3,246.00
Negri Sembilan	574.84	42.32
Pahang	85.83	.....
Total	3,470.60	3,897.64

10.73 piculs of mixed scheelite-cassiterite concentrates also were exported in 1914. The concentrates are treated as carrying 65 per cent WO_3, but are probably richer.

d Communicated by S. Katsuno, Tokyo, Japan. The figures given by Mr. Katsuno are 50,391 kwan; 3,808 kwan came from Ogasawara and Iida mines, Chosen. This is the first production reported from Chosen (Korea). The kwan is equal to 8.267 pounds.

e Exports from Bangkok. Foreign trade and navigation of the port of Bangkok, years 2456 (1913–14) and 2457 (1914–15), pp. 114, 115. The figures given are: 1913–14, 8.84 piculs, valued at 4,204 ticals; 1914–15, 489.46 piculs, valued at 28,574 ticals. In 1913–14 ticals averaged 13.04 to £1 ($4.867), and in 1914–15, 13.06 to £1. The Siamese year is from April 1 to March 31.

f Min. Jour. [London], vol. 110, p. 573, Aug. 7, 1915. The figures are quoted as from the Singapore trade returns and are 2,403 piculs of wolframite.

g Knibbs, G. B., Official yearbook Commonwealth of Australia, 1901–1913, p. 428. The figures given are 38 long tons. Has been treated as carrying 70 per cent WO_3.

h Queensland Sec. Mines Ann. Rept. for 1915, p. 24. The figures given are 240.9 long tons of wolfram and 193.05 long tons of mixed wolfram and bismuth. The mixed ore is arbitrarily considered to be half wolframite, as no percentages are given. The ore is also supposed to carry 70 per cent WO_3, the common standard in Australia.

i Victoria Sec. Mines Ann. Rept. for 1912, p. 24, 1913. Figures given are 10.05 long tons. See note *h* under Queensland.

j Statistical register of the State of Victoria, 1913, p. 754 (1915?). Figures given are three-fourths (long) ton, valued at £60. See note *h* under Queensland.

k Western Australia Dept. Mines Rept. for 1914, p. 101, 1915.

l Mines and quarries: General report, with statistics for 1914, pt. 1, pp. 16–17, district statistics: Home Office, London, 1914. The quantity given is 205 (long) tons. The percentage of WO_3 is not stated, but is probably above 60 per cent.

m Lowrie, W. L., Tungsten and other minerals of Portugal: Commerce Reports, Bur. For. and Dom. Com., Aug. 17, 1915, p. 836. Given as 753 (metric?) tons valued at $564,000. Thought to carry about 65 per cent WO_3 (wolframite).

n Mines statement for 1914: New Zealand Mines Dept. Rept., p. 14, Wellington, 1915. The figures given show that the exports during 1914 were 204 long tons of scheelite. It is assumed that the ore carried 72 per cent WO_3.

o Nova Scotia Dept. Mines Rept. for 1913, p. 12, 1913. Scheelite concentrates supposed to carry about 72 per cent WO_3.

p Figures furnished by Franklin D. Adams, chief clerk Pan American Bureau. As given they were: Exports, 394,160 kilograms tungsten ore, valued at 53,575 Argentine dollars. The Argentine dollar is equivalent to 96.5 cents. The content of WO_3 in the ore is unknown.

q Figures furnished by Franklin D. Adams, chief clerk Pan American Bureau. As given they were: 276,316 kilograms tungsten ore, valued at 428,300 bolivianos. The boliviano (gold) is worth 38.9 cents. The concentrates are thought to carry about 63 per cent WO_3.

r Jiminez, C. P., Estadística minera en 1913: Cuerpo Ing. Min. Bol. 81, 1915. Figures given are: 290 metric tons hübnerite concentrates carrying 194.3 tons WO_3.

s Fink, C. G., Tungsten: Mineral Industry, 1914, p. 756, 1915. Given as 130 metric tons. Hübnerite with less wolframite.

the figures depending on its treatment.[1] The specific gravity of iron is 8. A piece of tungsten therefore weighs more than twice as much as a piece of iron of the same size. The melting point of tungsten is so high that it can not be melted directly into a mass, and for this reason it is obtained from its ores only as a metallic powder. By indirect means it can be worked into solid masses ranging from wire 0.0002 inch (0.005 millimeter) in diameter [2] to more equidimensional pieces weighing 2 or 3 pounds. The processes used will probably be improved, so that larger pieces may be made if there is sufficient call for them.

Tungsten does not oxidize readily and is practically insoluble in the common acids. Its hardness varies from 4.5 (razor steel is from 5 to 5.5) to 8. It is therefore harder than quartz, which has a hardness of 7. It is, in fact, as hard as topaz.

Tungsten forms alloys with other metals and gives to steel both hardness and the property of holding its temper under higher temperatures than will carbon steel, and it is most largely used as an alloy of steel. About 7,000 tons of tungsten tool steels are made every year in this country.

The following table, given by Fink,[3] shows comparatively the properties of aluminum, copper, nickel, iron, and tungsten:

	Density at 18° C.	Coefficient of expansion at 18° C.	Tensile strength in pounds per square inch.	Modulus of elasticity in pounds per square inch.	Specific heat in calories, 1 gram −1° C.	Melting point in °C.	Elec. resist. in microhms per cu. cm.
Aluminum	2.7	21.8 by 10^{-6}	43,000	10 by 10^{6}	0.214	660	2.62
Copper	8.87	15.9 by 10^{-6}	66,000	19 by 10^{6}	.091	1,083	1.589
Nickel	8.75	12.7 by 10^{-6}	96,000	29 by 10^{6}	.106	1,453	6.93
Iron	7.8	11.2 by 10^{-6}	450,000	30 by 10^{6}	.105	1,600	8.85
Tungsten	19.6	3.5 by 10^{-6}	610,000	60 by 10^{6}	.034	3,267	4.42

NOTE.—The values given for iron in the third and fourth columns are for high tensile strength steel. As for the tungsten values here recorded, the specific heat figure is that of Honda, the melting point that of Langmuir; the others were determined by the writer.

Its high melting point, the toughness and fineness of the wire into which it may be drawn, and its behavior when an electric current is passed through it make it the best known material for incandescent electric lamp filaments, so that for this use it is rapidly driving other material from this market. Incandescent lamps filled with nitrogen or argon and having tungsten filaments are also taking the place of arc lamps for many purposes. Tungsten filament lamps are made in great numbers, but the filaments are so fine that an astonishingly small quantity of ore supplies the industry. Fink [4] states that "the total production of tungsten lamps, both vacuum and gas filled, in the United States in the year 1914 reached 100,000,000 [equivalent to 3 tons of tungsten concentrates]. The exports were 1,348,000 lamps, valued at $278,000."

[1] Fink, C. G., Ductile tungsten and molybdenum: Am. Electrochem. Soc. Trans., vol. 17, pp. 229–234, 1910. Also, by the same writer, Applications of ductile tungsten: Jour. Ind. and Eng. Chem., vol. 5, pp. 8–9, 1913.

[2] Hairs from the human head ordinarily range from 0.0012 to 0.003 inch (0.03 to 0.075 millimeter) in diameter.

[3] Fink, C. G., Mineral Industry for 1914, p. 759, 1915.

[4] Op. cit., p. 760.

For alloying steel both tungsten and ferrotungsten are used. Ferrotungsten is an alloy of iron and tungsten, carrying 50 to 85 per cent tungsten. It is claimed that less tungsten is lost when it is introduced into steel in ferrotungsten, and in general ferrotungsten can be made more easily than tungsten.

Tungsten is used largely instead of platinum and platinum-iridium alloys as contact points in spark coils, voltage regulators, telegraph relays, and spark plugs for automobiles. It is also used for phonograph needles. Fink[1] has described other uses and possible uses as follows:

Electric laboratory furnaces with tungsten resisters are of two types. In one a tungsten wire is wound on an alundum tube in an air-tight box with a hydrogen atmosphere. In the second a tungsten metal tube takes the place of the helical carbon resister in an Arsem vacuum furnace.

Tungsten gauze is used successfully for separating solids from acid liquors in the laboratory. This gauze could well be used on a commercial scale; for example, for the removal of sludge from copper-refining baths, and for centrifugal apparatus in general whenever acid liquids or acid gases are dealt with. Furthermore, it might be used in apparatus such as described by Cottrell for the removal of sulphuric mist from gases.

Wrought tungsten targets for Roentgen tubes have proved to be one of the most interesting applications.

For thermocouples the tungsten-molybdenum couple is not less interesting. The electromotive force increases with the temperature up to about 540° C. (12½ millivolts), then decreases and passes through 0 millivolts at about 1,300° C. This couple is very convenient for high-temperature measurements in the tungsten-hydrogen furnace.

For standard weights tungsten is also well suited, since wrought tungsten can be made so hard that it will readily scratch glass and still be ductile; furthermore, the density is high (19.3 to 21.4), and it is unaffected by the atmosphere. Tungsten weights remain wonderfully constant.

Besides the applications of tungsten cited above, many others have been but partly worked out and others merely suggested. Owing to its chemical stability the finest sizes of wire down to 0.0002 inch or 0.005 millimeter in diameter are well adapted for galvanometer suspension and for cross hairs in telescopes. It has also been suggested to use these fine wires in surgical operations in place of the coarser gold and silver wires. A further suggestion is the use of the wire in musical instruments.

Acid-proof dishes and tubes have been made out of tungsten; furthermore, tungsten wire recommends itself as a unit resistance, since it can be made absolutely pure, can be easily duplicated, and is not corroded.

Since tungsten is paramagnetic and elastic, it is being tried out in electrical meters, replacing the phosphor-bronze springs. Similarly watch springs could be made which would never become magnetized.

Finally, Fink mentions tungsten writing pens, tungsten drawing dies, tungsten knife blades, tungsten reinforced asbestos curtains and fireproof coverings, and other articles.

The valves of some automobile engines are made of an iron-tungsten alloy and are said to stand the wear much better than iron or steel.

IMPORTS.

During 1914, as shown by the figures compiled by the division of statistics, Bureau of Foreign and Domestic Commerce, the imports of tungsten-bearing ores for consumption amounted to 299 tons, valued at $139,687, and 218 short tons of tungsten metal and ferrotungsten, valued at $222,447.

[1] Fink, C. G., Paper delivered before the section of electrochemistry, Eighth Internat. Cong. Applied Chemistry, Sept. 6, 1912: Metall. and Chem. Eng., vol. 10, pp. 580-581, 1912; also Jour. Ind. and Eng. Chem., vol. 5, pp. 8-9, 1913.

FIELD TEST FOR TUNGSTEN.

In general, tungsten minerals are found in regions of granitic rocks, though some are found where the granular rocks do not appear at the surface in close connection with the veins. The tungsten produced in the United States and in other countries is obtained almost wholly from areas of quartzose granular igneous rocks or from areas intruded by them.

The mineral to be tested should first be finely pulverized and then digested with hydrochloric (muriatic) acid. This test may be made in any receptacle which is not attacked by the acid—a tumbler, bottle, teacup, or test tube. If the mineral is scheelite the digestion will need to be carried on but a few minutes, but wolframite, hübnerite, or ferberite should be boiled for 10 to 20 minutes, or be heated to a lower temperature for a longer time. If the specimen tested contains tungsten minerals, a yellow powder, tungsten trioxide, WO_3, will be produced, though it may be masked by iron or other impurities. On the addition of metallic zinc the solution will turn indigo blue if sufficient tungsten trioxide has been formed. The depth of the color, and even the color itself, will depend largely on the extent of the digestion and the quantity of tungsten in the specimen tested. If only a little tungsten trioxide has been formed, the blue will be light, or even indistinguishable, and will be followed by violet and later by brown. If a considerable quantity of the trioxide has been formed, the blue will be very deep and the violet will probably not appear, a muddy brown color succeeding the blue more or less quickly. Metallic tin, a piece of "tin" from a "tin" can, or even a piece of solder may be used instead of the zinc, but they do not act so readily, and the reactions, except with pure tin, are not always so satisfactory.

RADIUM, URANIUM, AND VANADIUM.

By Frank L. Hess.

PRODUCTION.

The year 1914 was an eventful one in the industry of mining ores of radium, uranium, and vanadium, and showed by far the largest annual output yet made, amounting to 4,294 short tons of dry ore carrying 87.2 tons of uranium oxide, U_3O_8, and 22.3 grams of metallic radium. The ore was valued at about $441,300. The ore produced in 1913 contained 41 tons of uranium oxide and 10.5 grams of radium, and that produced in 1912 contained 26 tons of uranium oxide and 6.7 grams of radium. About nine-tenths of the radium is thought to be recoverable under improved processes.

The radium-uranium ores mined were all of the oxidized type and nearly all were carnotite ores. The only other uranium ore mined was that containing uvanite, to which reference will be made in another paragraph.

Although carnotite, $K_2O.2UO_3.V_2O_5+8H_2O$, contains three times as much uranium oxide as vanadium oxide, the Colorado and Utah carnotite ores generally contain other vanadium minerals in quantity so large that the vanadium oxide content of the ores is larger than that of uranium oxide. Little is paid for the vanadium, however, as its separation from uranium is troublesome, and only a few thousand dollars was received in 1914 by brokers or producers for the vanadium in the ores sold. Sandstone impregnated with roscoelite, a vanadium-bearing mica, is mined by the Primos Chemical Co. at Vanadium, San Miguel County, Colo., on the eastern edge of the carnotite field. The total quantity of vanadium in the carnotite and other ores mined during the year was apparently about 452 tons.

About the beginning of 1914, owing to the very high prices charged for radium salts, their scarcity, their apparent usefulness in treating cancer and other diseases, some of which have hitherto been incurable, to the practical impossibility of the poor receiving treatment by radium because of its scarcity and high cost, and to the fact that much of the radium-bearing ore was being shipped out of the country, Secretary of the Interior Lane caused to be introduced in Congress bills reserving radium-bearing lands from entry as mining claims, and providing for the purchase of ores by the Government. The bills were still pending at the close of the year.

During the year the National Radium Institute (Inc.), acting under the supervision of the Bureau of Mines, conducted mining operations on claims of the Crucible Steel Co. in Long Park, on the north side of Paradox Valley, in Montrose County, Colo., and maintained a plant at

Denver for producing radium and for investigating processes. The results of the work were so encouraging that Director Holmes announced the probable production of radium at one-third of the price usually demanded. Messrs. Lind and Whittemore, of the Bureau of Mines, state that their investigations have shown that carnotite carries proportionately to its content of uranium as much radium as pitchblende or other uranium minerals—that is, in carnotite the radium has reached its maximum ratio to the uranium from which it is derived and is thus in equilibrium. The published results of experiments made on some specimens of carnotite had led to the popular supposition that carnotite was not so rich as pitchblende in radium.

During the year the Standard Chemical Co., in Utah, made the first commercial production of carnotite ores from the Henry Mountains, and the commercial production of uvanite,[1] a radium-bearing mineral new to science, accompanied by other uranium minerals, one or more of which are yet to be described, was begun at Temple Rock, 45 miles southwest of Green River. Shipments were made from newly opened carnotite deposits at Court House, northwest of Moab, Utah, and from deposits 16 or 18 miles southeast of Moab. A first shipment was also made from Blue Mountain, Routt County, Colo.

The Paradox Valley region was, however, as usual, the chief producing area, and yielded most of the ores mined. The Standard Chemical Co. was the largest single producer and shipped more than half of the country's output.

Besides the National Radium Institute, two other companies, the Standard Chemical Co. and the Radium Co. of America, produced radium salts during the year, and Dr. W. A. Schlesinger started a radium-refining laboratory. The European war stopped nearly all operations in both mines and reduction plants, for the two companies mentioned sold their product largely in Europe and practically all the ore bought by brokers was sold abroad. A little more than 1,200 tons of ore, containing 27 tons of uranium oxide and 7 grams of radium, was consigned to Europe, but as the foreign refineries were closed, a part of it was held in transit.

No vanadinite or similar ores are known to have been sold for vanadium during the year, but a number of mines in New Mexico and Arizona shipped and sold such ores for their content of lead and silver. No radium or vanadium salts are known to have been imported during the year, though some ferro-vanadium may have been imported. Oxide and salts of uranium valued at $1,176 were imported during the year.

TESTS FOR URANIUM-RADIUM MINERALS.

All minerals that carry uranium also carry radium, which is now considered a product of the atomic decomposition of uranium. A test for radioactivity is, however, not a conclusive test for radium and uranium, for thorium also has a decomposition

[1] Hess, F. L., and Schaller, W. T., Pintadoite and uvanite, two new vanadium minerals from Utah: Washington Acad. Sci. Jour., vol. 4, pp. 578–579, 1914.

product, mesothorium, which closely resembles radium in its behavior. Tests for radioactivity will therefore show only whether the specimen contains radium and uranium or mesothorium and thorium. The appearance of the minerals will generally determine which of the elements is present, but in case of doubt the determination requires more elaborate tests, which should be made by an experienced chemist.

To test for radioactivity lay the mineral to be tested on a plate holder containing a sensitive photographic plate, and if uranium is present in any considerable quantity the plate will be light-struck within a period ranging from 12 hours to a week, the time depending on the amount of radioactive matter in the specimen.

When objects are laid directly upon a sensitized film or plate deceptive effects are obtained by pressure. Many supposed "radiographs" made by mere pressure have been sent to the Survey. In some of these the sensitized coating has been entirely removed under the object and the remainder was so light-struck that the experimenter thought he had obtained a "reversed" effect.

CONSTANTS OF RADIUM, URANIUM, AND VANADIUM.

It is not easy to keep in mind the figures necessary for estimating the quantity of radium, uranium, or vanadium present in a mineral or ore of given tenor, so the constants most used in such estimates are given below.

Atomic weights: Br, 79.92; Cl, 35.46; O, 16; Ra, 226.4; U, 238.5; V, 51.

Molecular weights and ratios: UO_3, 286.5 = 1.201 U; U = 0.8325 UO_3; U_3O_8, 844 (843.5) = 1.179 U_3; U_3, 715.5 = 0.8483 U_3O_8; V_2O_5, 182 = 1.784 V_2; V_2, 102 = 0.56 V_2O_5. The ratio of U_3O_8 to V_2O_5 in carnotite or tyuyamunite $(K_2,Ca)O.2UO_3.V_2O_5 + 8?H_2O$, is 3.09 to 1; that is, there is 3.09 times as much U_3O_8 as V_2O_5. The ratio of uranium to vanadium in carnotite or tyuyamunite is 4.68 to 1. The ratio of the molecular weight of hydrous radium bromide, $RaBr_2$ $2H_2O$, 422.2, to the radium it contains is 1.865 to 1, or the radium is equal to 0.5362 of the hydrous radium bromide.

Gross weights: 1 ton U_3O_8 contains 1,697 pounds (769.75 kilos) of uranium.

"One gram radium is present in a quantity of mineral containing 3,000 kilos of uranium."[1] Therefore one-third of a milligram of radium is present in 1 kilo of uranium (1 kilogram = 2.2046 pounds; 1 short ton (2,000 pounds) = 907.194 kilograms).

One ton of uranium (elemental) contains 302.4 milligrams of radium.

One ton of U_3O_8 contains 256.58 milligrams of radium.

One ton of ore containing 1 per cent of U_3O_8 carries 2.566 milligrams of radium (elemental), equivalent to 4.787 milligrams hydrous radium bromide.

TESTS FOR VANADIUM.

Most of the vanadium minerals, especially those of the oxidized zone, are readily soluble in mineral acids. Hydrochloric is the most convenient acid to use. If concentrated hydrochloric acid, HCl, is put upon carnotite, uvanite, vanadinite, the descloizites, and some

[1] Rutherford, E., Radioactive substances and their radiations, p. 462, 1913.

other vanadium minerals, it immediately gives a rich red-brown solution. If water is added the color changes to green or disappears. If the dilution is not too great the brown color reappears on the addition of hydrogen peroxide, H_2O_2. If metallic zinc is added the green color will again appear and may gradually fade until the solution becomes colorless.

Calcium vanadate and a few other oxidized minerals do not show the brown-red color at once, but must be treated with the acid for a longer time. Heating will hasten the reaction.

If dilute acid is used the solution is ordinarily greenish, yellowish (from uranium), or nearly colorless. The addition of hydrogen peroxide gives the reddish-brown color, and added zinc will again bring the green color or decolorize the solution. Vanadium-bearing silicates, such as roscoelite, may be treated with dilute acid and either be allowed to stand for some time or be boiled, after which good reactions may be obtained.

With carnotite, vanadinite, the descloizites, and some other minerals, it is only necessary to place a drop of concentrated hydrochloric acid upon the mineral to get the rich red-brown color almost immediately. The addition of 2 or 3 drops of water makes the color change to light green or disappear.

ANTIMONY.[1]

By Frank L. Hess.

INTRODUCTION.

The antimony resources of the United States are not well known, owing partly to a lack of exploitation of known deposits and partly to a lack of adequate field study by those who are willing to publish the results of their studies. There has been little prospecting for antimony and comparatively little work has been done on any but the richest and most conveniently located deposits, for prices have in general been too low to make mining on a small scale profitable, and the market has been uncertain and has probably not been large enough to absorb the product of large operations even if ore bodies of sufficient extent to furnish a big output had been found. Some of the known ore bodies have lacked value because of their content of arsenic, zinc, or lead minerals, for so long as buyers can obtain antimony ores free from these minerals they refuse to purchase ores containing them in considerable quantity. The world now uses probably only 30,000 to 35,000 tons of antimony a year aside from that contained in antimonial or hard lead, and by comparing this quantity with the quantities of other metals used, it is readily seen how easily prices might be lowered by overproduction; thus about 114,000 tons of tin, 1,094,000 tons of zinc, 1,099,000 tons of copper, and 1,309,000 tons of lead were produced in 1913.[2]

During the early part of 1914 the prices of antimony were low, and when in the later half of the year the demands caused by the European war raised them they were so unsteady that they offered little inducement to miners and prospectors to produce the ore, and none is known to have been mined and sold in the United States during the year.

A little antimony has been isolated electrolytically from the anode muds left in the electrolytic refining of lead, and in 1914 the Raritan Copper Works separated a few tons from the anode muds of blister copper made from Butte ores. Blister copper produced from the smelter at Washoe, Mont., in 1914 carried 0.014 per cent of antimony and that from the smelter at Great Falls, Mont., carried 0.020 per cent, or 28 and 40 pounds per 100 tons, respectively.[3] Although the output may be increased somewhat, it can never be large.

[1] Chemical symbol, Sb; atomic weight, 120.2; specific gravity, 6.70; melting point, 629.2° C. See also Day, A. L., and Sosman, R. B., The melting points of minerals in the light of recent investigations on the gas thermometer: Am. Jour. Sci., 4th ser., vol. 31, p. 345, 1911.

[2] Metal statistics, 1915: Compiled by the Am. Metal Market and Daily Iron and Steel Report, New York, 1915.

[3] Letter from F. L. Antisell.

PRODUCTION.

Antimony ores can not be worked profitably at the usual prices under the high cost of labor in the mining regions of the United States unless the deposits are very large and advantageously situated, and no deposits have been found that fulfill these conditions. As a result practically all the antimony metal used here is imported from European, Chinese, and Japanese smelters. Most of the ores for these smelters come from China, Mexico, and France, though smaller quantities are obtained from Japan, Austria, and other countries.

For several years the production of antimony in the United States from domestic ores has been confined to that contained in antimonial lead and the small quantities recovered in the electrolytic refining of copper and lead. A small quantity of antimony, determinable only by estimate, is produced from foreign ores.

The domestic production since 1910 is shown below.

Production of antimony in the United States, 1910–1914, in short tons.

Year.	Contained in antimonial lead of domestic origin.		Contained in antimonial lead of foreign origin, but smelted in the United States.		Average percentage of antimony in antimonial lead.	Recovered from old alloys, scrap, and dross.[a]	
	Quantity.	Value.	Quantity.	Value.		Quantity.	Value.
1910	1,598	[b] $263,431	631	[b] $103,906	15.85	2,779	[b] $457,979
1911	1,543	[c] 264,780	711	[c] 122,006	16.01	2,369	[c] 406,520
1912	1,224	[d] 209,059	725	[d] 123,830	14.38	2,506	[d] 428,025
1913	2,204	[e] 375,562	304	[e] 53,801	15.05	2,705	[e] 460,932
1914	2,530	[f] 529,740	175	[f] 36,750	16.16	2,645	[f] 555,450

[a] Figures collected by J. P. Dunlop, United States Geological Survey. In 1910 a total of 9 tons; in 1911, 10 tons; in 1912, 13 tons; in 1913, 45 tons; and in 1914, 1 ton, was recovered as antimony, the remainder as alloy.
[b] Estimated at 8.24 cents a pound.
[c] Estimated at 8.58 cents a pound.
[d] Estimated at 8.54 cents a pound.
[e] Estimated at 8.52 cents a pound.
[f] Estimated at 10.5 cents a pound. Includes actual marketed value of a few tons of antimony made as a by-product in the electrolytic refining of copper.

The prices per pound represent the average, and the values are not exact. Antimonial lead is generally alloyed with arsenic, iron, and copper, but pure antimony and pure lead can not be obtained from the alloy at a cost low enough to afford a profit, though the alloy sells at a lower price than the metals singly. Antimonial lead is sometimes sold at the price of the antimony it contains, supposing it to be equal to Cookson's plus that of the lead, minus $5 a ton. For the year 1914 the value of the antimony content of antimonial lead has been figured at 10.5 cents a pound, the average price of Cookson's during the year.

IMPORTS.

For years large quantities of antimonial lead were imported into the United States as "type metal," for which it is largely used; but during the last three years these imports have been much smaller. The following table is taken from the records of the Bureau of Foreign and Domestic Commerce:

Type metal imported and entered for consumption, 1905–1914, in short tons.

Year.	Type metal.		Antimony content.	
	Quantity.	Value.	Quantity.	Percentage.
1905	6,966	$456,155	1,228	17.6
1906	9,801	900,608	1,853	18.9
1907	7,416	932,027	1,369	18.5
1908	2,055	156,847	422	20.5
1909	6,997	532,108	1,327	19.0
1910	6,697	485,493	1,109	16.6
1911	4,195	310,658	727	17.3
1912	291	18,668	52	17.2
1913	284	20,098	50	17.6
1914	755	45,373	94	12.4

The customs returns give only the lead content of imported type metal, and the figures given above are based on the assumption that the remainder is practically all antimony, but this assumption is wholly arbitrary, for imported type metal contains as much as 2 per cent of impurities, such as iron, arsenic, and copper. The antimony content is therefore probably too large by some quantity less than or approximately equal to 2 per cent of the total quantity of type metal, and the correct percentage is correspondingly lower.

In the table below the imports of antimony and antimony ore entered for consumption since 1904, as compiled by the division of statistics of the Bureau of Foreign and Domestic Commerce, are given in order to show the great variation in both quantity and value of the imports from year to year. The imports of salts of antimony are given from 1904 to 1910, but not for 1911 and 1912. They are included, however, in the figures for the last three months of 1913 and in those for 1914.

Antimony, antimony ore, and salts of antimony imported and entered for consumption in the United States, 1904–1914, in pounds.

Year.	Metal (regulus).[a]		Crude antimony[b] and ore.		Oxide and salts of antimony.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1904	4,268,045	$248,726	2,488,518	$50,414	981,026	$70,668	$369,808
1905	4,941,247	431,228	1,970,788	53,026	1,010,228	80,130	564,384
1906	10,305,734	1,391,289	1,972,658	125,841	764,070	99,251	1,616,279
1907	9,600,901	1,407,861	2,771,387	180,903	682,192	98,038	1,686,802
1908	8,089,915	771,206	3,287,218	106,930	623,125	65,898	944,034
1909	9,557,956	620,117	3,453,542	94,249	955,360	60,353	774,719
1910	7,955,945	492,570	1,346,962	47,185	326,136	14,201	553,956
1911	8,486,137	470,552	1,641,467	60,459	[c] 1,003,647	54,426	585,437
1912	13,936,873	808,473	1,562,066	51,444	[c] 1,759,908	81,077	940,994
1913	12,479,727	798,581	4,021,486	137,780	[d] 1,968,475	117,169	1,053,530
1914	13,110,426	736,420	2,606,349	75,345	2,744,406	315,001	1,126,766

[a] "Regulus" is a term which has been handed down from the alchemists and should be allowed to become obsolete. As now used it merely means "metal," so that "antimony," "regulus" and "refined antimony," which from year to year are noted in the reports of various governments, are redundants.

[b] "Crude antimony" is an awkward and misleading term meaning "liquated stibnite." It is also known as "needle antimony."

[c] Oxide only. No figures showing the imports of antimony salts were given in the customs returns.

[d] Includes imports of salts for the last three months of 1913.

PRICES.

The price of antimony did not fluctuate greatly during the six years preceding 1914, the extreme monthly averages given by the American Metal Market and Daily Iron and Steel Report [1] being 7.22 and 10.31 cents a pound for Cookson's antimony, and both prices prevailed in 1913, the lower being that for February and the higher that for November. Hallett's generally sells for about one-fourth cent a pound lower than Cookson's, and other brands are still lower, the price depending on quality and on reputation, which seems to be fully as important. The average price of Cookson's for 1913 was 8.52 cents a pound.

In 1914, however, the price fluctuated considerably after the beginning of the European war. From January to the end of July the monthly average prices of Cookson's antimony ranged from 7.31 cents a pound in January to 7.11 cents a pound in July. In August the average rose to 16.23 cents, but fell to 12.19 cents in September. In November the average was 17.26 cents and in December 15.82 [2] cents. For a time in August Cookson's sold at 20 cents. During the first seven months Hallett's was two or three tenths of a cent below Cookson's, but later the difference was greater. Hungarian was lower. Quotations are not at hand for other brands. The average monthly prices, as given by the authority quoted, are as follows:

Average monthly prices in cents of Cookson's, Hallett's, and Hungarian grade antimony (ordinary brands) in New York, 1914, by months.

Month.	Cookson's.	Hallett's.	Hungarian.
January	7.31	7.02	6.03
February	7.24	7.00	6.00
March	7.23	6.95	5.94½
April	7.22	7.90	5.82
May	7.29	6.89½	5.78
June	7.21	6.85	5.62½
July	7.11	6.79	5.44
August	16.23	14.90	13.05
September	12.19	11.19	9.79½
October	13.87	12.78½	11.64
November	17.26	15.84	14.14
December	15.82	14.74	13.15
Average	10.50	9.82	8.53½

CONSUMPTION.

The approximate domestic consumption of antimony is equal to the production, recovery, and imports. The consumption in 1914 was roughly as follows:

[1] Metal Statistics, 1913, p. 243.

[2] All prices are taken from The American Metal Market and Daily Iron and Steel Report, and from its Metal statistics, 1915.

Domestic consumption of antimony in 1913 and 1914, in short tons.

	1913.		1914.	
	Quantity.	Value.	Quantity.	Value.
Antimony contained in antimonial lead from all sources, including by-product antimony	2,540	$430,491	2,799	$587,230
Recovered from wastes, scrap, etc. (including a little ore), nearly all as alloy	2,775	462,115	2,645	555,450
Imports:				
Metal	6,240	798,581	6,555	736,420
Crude antimony and ore (probable antimony content)	1,200	137,780	1,303	273,630
Approximate consumption of metallic antimony	12,755	1,828,967	13,302	2,152,730

A few tons of Nevada ore which had been held for several years were smelted by the Hoyt Metal Co. of St. Louis.

FOREIGN PRODUCTION OF ANTIMONY.

According to figures collected by the British Home Office,[1] from various official sources, the world's output of antimony and antimony ore in 1911 and 1912 was as follows:

World's production of antimony in 1911 and 1912.

[In metal unless otherwise noted. Tons of 2,000 pounds.]

	1911	1912
	Quantity.	Quantity.
Algeria (ore)	.....	5,139
Argentina	34	Not stated.
Australia:		
New South Wales (ore and metal)	186	71
Queensland (metal)	11	.....
Victoria (ore)	1,230	2,722
Austria (ore)	298	4,983
Bolivia (ore)	344	100
Canada: Nova Scotia (ore)	192	.....
China, exports:		
Metal	7,702	14,914
Ore	7,509	2,265
France (ore)	32,267	12,147
Hungary:		
"Crude" and metal	983	947
Ore	88	72
Italy (ore)	2,691	2,070
Japan:		
Crude	1	14
Refined	106	69
Mexico:		
Ore	133	17
Metal	4,554	3,849
Portugal (ore)	.....	110
Servia (ore)	186	327
Spain (ore)	110	551

The world's production for 1913 has been discussed by the Mining Journal [London] [2] as follows:

The generally low prices which have ruled for antimony since 1905 have had the effect of restricting output among small producers, and production is now confined

[1] Mines and Quarries, 1912, pt. 4, Colonial and Foreign Statistics, 1913.
[2] Editorial, vol. 108, p. 3, Feb. 6, 1915.

largely to China and France, where the researches of metallurgists like Messrs. Chatillon and Herrenschmidt have developed processes which have brought the poor ores so abundant in the French mines within the range of payability. We may take the world's production in 1913 at roughly 22,000 tons of regulus, crude and refined, made up approximately as follows:

	Long tons.
China	12,820
France	6,000
Mexico	2,315
Hungary	860
Total	[21,995]

In addition there were small amounts of ore totaling perhaps 8,000 tons, embracing about 5,000 tons from China and about 2,000 from Australia, the average tenor of which is uncertain.

ARSENIC.

By Frank L. Hess.

INTRODUCTION.

In 1914 the output in the United States of white arsenic or arsenious oxide (commonly known as "arsenic") amounted to 4,670 short tons (of 2,000 pounds), valued at $313,147. This value, however, is somewhat uncertain. It is made up in part of values reported from the works and in part of values reported from places of sale. The values reported from the works are higher than those reported from the places of sale. The production exceeded the largest previous annual output—that of 1912 (3,141 tons, valued at $190,757)—by nearly 49 per cent. No white arsenic from minerals treated primarily for their content of arsenic has been directly produced in this country for several years, because the arsenic saved at the smelters as a by-product and the imported material have been so plentiful and so cheap that direct production would have been unprofitable.

CHARACTERISTICS OF ARSENIC.[1]

Arsenic is an element which is generally classed among the nonmetals, though it has some of the characteristics of a metal. Its appearance and luster are metallic and it forms with several metals compounds which, though brittle, correspond to true alloys, such as hard lead, a compound of arsenic and lead, and several varieties of speculum metal,[2] but the addition of arsenic to most metals makes an alloy which is too brittle. Arsenic is electrically positive and is a good conductor of electricity[3] and of heat.

On freshly exposed surfaces arsenic is steel gray but it soon becomes tarnished and blackened, possibly by the formation of a suboxide, and then changes to the white arsenious oxide, As_2O_3—the "arsenic" of commerce. Most of its soluble compounds are highly poisonous.

In most of its mineral combinations and in all of its 90 oxygen-bearing minerals, except the simple oxides, arsenic acts as an acid-forming element. The only minerals in which arsenic may be considered to act as a base are the sulphides and possibly the oxides.

ARSENIC MINERALS.

The number of arsenic minerals—that is, the minerals of which arsenic forms either a major or a minor constituent—is very large, 130 or more, the exact number depending on the strictness with

[1] Chemical symbol, As; atomic weight, 74.96; specific gravity (crystallized), 5.73; melting point under pressure, 500° C. If heated at ordinary atmospheric pressures arsenic volatilizes without melting.
[2] Brannt, W. T., The metallic alloys, p. 243, 1908.
[3] Fowle, Frederick E., Smithsonian physical tables, 6th ed., p. 274, 1914. Quoted from Mathiessen.

which definitive lines are drawn. As the known minerals number about 1,100 it will be seen that nearly 12 per cent of them are arsenic bearing.

Arsenic is occasionally found native, and it appears from its structure and from its occurrence in the parts of veins which are subject to oxidation that it is probably always a secondary mineral, though Beyschlag, Vogt, and Krusch[1] consider it primary. According to Dana,[2] crystals of native arsenic are rare, and it is generally granular massive, but some specimens are reticulated, reniform, or stalactitic, and it is rarely found with columnar structure. Most if not all of the specimens seen by the present writer have been more or less laminated. It is everywhere in too small quantity to be of commercil value.

Three arsenic sulphides are known: Arsenschwefel, $As_2S_3.H_2O$, orpiment, As_2S_3, and realgar, AsS. Arsenschwefel is probably always of secondary origin—that is, formed through the breaking down of other minerals and under oxidizing conditions. Orpiment and realgar are probably formed at shallow depths and are both original and secondary minerals. Orpiment and realgar have been found as a hot-spring deposit in the Norris Geyser basin[3] in Yellowstone Park, in crusts more than an inch thick, accompanied only by siliceous sinter. Becker described the occurrence of arsenic sulphide, apparently orpiment, in the siliceous sinter at Steamboat Springs.[4] Realgar and orpiment are found in short veins reaching 4 inches in thickness in Eocene shales in the valley of Coyote Creek, near Coyoto, Utah,[5] adjacent to antimony deposits, though not visibly connected with them. The veins contain no other minerals, and the two arsenic minerals are intimately mixed. The origin of the deposits is probably closely connected with the extrusion of the andesitic lava which covers the surrounding plateau.

Spurr[6] describes the occurrence of realgar in the upper levels of the mines at Monte Cristo, Wash., and states that in the lower levels it gives way entirely to arsenopyrite, from which he believes it has been derived. Beyschlag, Vogt, and Krusch[1] consider orpiment and realgar as primary minerals.

Realgar is found in small quantity with stibnite in the White Cap and one or two other gold mines at Manhattan, Nev.[7]

Oxide of arsenic, As_2O_3, or white arsenic is found native, crystallized in two forms and known as: Arsenolite, As_2O_3 (isometric) and claudetite, As_2O_3 (monoclinic). They are secondary minerals and occur in very small quantities, and are in fact of only mineralogic importance. This statement, however, applies to practically all the oxyarsenical minerals, though scorodite is found in considerable quantity in the outcrops or upper parts of some veins.

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[1] The deposits of the useful minerals and rocks; their origin, form, and content, trans. by S. J. Truscott, vol. 1, p. 101, London, 1914.

[2] System of mineralogy, 6th ed., p. 11.

[3] Weed, W. H., and Pirsson, L. V., Occurrence of sulphur, orpiment, and realgar in the Yellowstone National Park: Am. Jour. Sci., 3d ser., vol. 42, pp. 403–405, 1891.

[4] Becker, G. F., Geology of the quicksilver deposits of the Pacific slope: U. S. Geol. Survey Mon. 13, pp. 343–346, 1888.

[5] Richardson, G. B., Antimony in southern Utah: U. S. Geol. Survey Bull. 340, pp. 255–256, 1908.

[6] Spurr, J. E., The ore deposits of Monte Cristo, Wash.: U. S. Geol. Survey Twenty-second Ann. Rept., pt. 2, p. 837, 1901.

[7] Personal communication from H. G. Ferguson.

Minerals in which arsenic is combined with a metal and especially with a metal and sulphur are common to most primary ore deposits—that is, to most ore deposits that have not been transferred by solution and reprecipitation from their original places of deposition. These minerals include arsenides of antimony, bismuth, cobalt, copper, iron, nickel, and platinum, all of which except antimony are rather strongly basic metals. The following native arsenides are known: Allemontite, $SbAs_3$; smaltite, $CoAs_2$ (isometric); safflorite, $CoAs_2$ (orthorhombic); skutterudite, $CoAs_3$; domeykite, Cu_3As; ledouxite, Cu_4As; algodonite, Cu_6As; whitneyite, Cu_9As; arsenoferrite, $FeAs_2$ (isometric); löllingite, $FeAs_2$ (orthorhombic); leucopyrite, Fe_3As_4; niccolite, NiAs; chloanthite, $NiAs_2$ (isometric); rammelsbergite, $NiAs_2$ (orthorhombic); maucherite,[1] Ni_4As_3; sperrylite, $PtAs_2$.

All but two (antimony and copper) of the metals of which native arsenides are known belong to the eighth group of Mendeleef's periodic system. Of the other members of the eighth group, rhodium and a trace of palladium occur in sperrylite, the platinum arsenide, and may perhaps occur as arsenides. Palladium may possibly occur in the Sudbury nickel ores[2] and in various copper ores as an individual arsenide. No arsenides of metals that are normally acid-forming—such as molybdenum, tantalum, tungsten, and uranium—have been found as minerals, though some artificial arsenides have been prepared. Nor are arsenides known of many of the metals that are strongly basic, such as cadmium, lead, manganese, potassium, silver, sodium, and zinc, though doubtful arsenides of manganese and silver have been reported.

So far as is known the arsenides are not enriched by the downward movement of surface waters. They are primary minerals, and they are not known to be taken up at one place and redeposited at another by the solutions which ordinarily occur in the zone of sulphide enrichment.

Six sulpharsenides are known, and they hold in combination four metals—bismuth, cobalt, iron, and nickel. They are: Arsenopyrite, FeAsS; glaucodot, (Co,Fe)AsS; alloclasite, (Co,Fe,Bi)AsS; cobaltite, CoAsS; corynite, Ni(As,Sb)S (isometric); wolfachite, Ni(As,Sb)S (orthorhombic).

The iron arsenosulphide, arsenopyrite (orthorhombic), is by far the commonest arsenic mineral. Danaite is a variety of arsenopyrite in which the iron is partly replaced by cobalt. Glaucodot is a variety in which the quantity of cobalt about equals or exceeds the iron present. Alloclasite may be considered as glaucodot containing some bismuth, or as a variety of arsenopyrite containing both cobalt and bismuth. Cobaltite is an isometric cobalt arsenosulphide. Corynite and wolfachite are respectively isometric and orthorhombic sulpharsenides of nickel, in which antimony replaces a part of the arsenic. Pure sulpharsenides of both bismuth and nickel may at

[1] Named temiskamite by T. L. Walker (Temiskamite, a new nickel arsenide from Ontario: Am. Jour. Sci. vol. 37, pp. 170–172, 1914). Chase Palmer (Studies in silver enrichment. Tetranickel-triarsenide, its capacity as silver precipitant: Econ. Geology, vol. 9, pp. 664–674, October, 1914), has shown, however, that under the name maucherite the same mineral had been well described except as to its chemical composition.

[2] Dr. A. P. Coleman (The nickel industry with special reference to the Sudbury region, Ontario: Mines Branch, Ottawa, p. 29, 1913) says: "It is known that palladium occurs in the Sudbury ores in larger amounts than platinum, but no palladium compound has yet been discovered."

some time be found. The sulpharsenides appear to be primary minerals, though Spurr, in his work upon the gold and silver deposits of Monte Cristo, Wash.,[1] states that insignificant quantities of the arsenopyrite are secondary, because it is deposited with calcite.

Arsenopyrite is formed under greatly varying conditions of depth, but mostly in the deepest vein-forming zones.

With sulphur arsenic forms sulpharsenites and sulpharsenates, which have analogues in the sulphantimonites and sulphantimonates and into which they merge by the substitution of antimony for arsenic. Only five metals—copper, iron, lead, silver, and thallium—are known thus to combine under natural conditions with arsenic and sulphur. Lead, which is unknown as an arsenide or sulpharsenide, has been found in nine of the fifteen recorded sulpharsenites. Several of the minerals described are not certainly distinct species. Zinc is shown in small quantity in analyses of pearceite, but is possibly present in the form of sphalerite or as an impurity. The sulpharsenite minerals are: Tennantite, $4Cu_2S.As_2S_3$; seligmannite, $Cu_2S.2PbS.As_2S_3$; lengenbachite, $(Cu,Ag)_2S.6PbS.2As_2S_3$(?); dufrenoysite, $2PbS.As_2S_3$; rathite, $3PbS.2As_2S_3$; guitermanite, $3PbS.As_2S_3$; jordanite, $4PbS.As_2S_3$; baumhauerite, $4PbS.3As_2S_3$; liveingite, $5PbS.4As_2S_3$; proustite, $3Ag_2S.As_2S_3$; trechmanite, $Ag_2S.As_2S_3$ (rhombohedral); smithite, $Ag_2S.As_2S_3$ (monoclinic); pearceite, $9Ag_2S.As_2S_3$; lorandite, $Tl_2S.As_2S_3$; hutchinsonite, $(Tl,Ag,Cu)_2S.As_2S_3 + PbS.As_2S_3$(?); vrbaite, $TlAs_2SbS_5$.

There is some question about the composition of hutchinsonite, guitermanite, seligmannite, and lengenbachite, but they probably belong in this class of minerals. Tetrahedrite, the sulphantimonite analogue of tennantite, almost invariably contains arsenic, and through the domination of one or the other element the minerals grade into each other.

In general, the sulpharsenites should probably be considered secondary minerals. Thus, proustite, $3Ag_2S.As_2S_3$, and pyrargyrite, the corresponding antimony compound, which is, however, commonly arsenical, are both generally considered secondary minerals.[2] Pearceite, $9Ag_2S.As_2S_3$, is also thought to be secondary,[3] and tennantite, $4Cu_2S.As_2S_3$, is said to be secondary at Butte,[4] though tetrahedrite, the corresponding antimony compound, which, however, generally carries arsenic, is ordinarily thought to be primary.

Three sulpharsenates, with copper, iron, and silver as bases, are known: Enargite, $3Cu_2S.As_2S_5$; epigenite, $4Cu_2S.3FeS.As_2S_5$; xanthoconite, $3Ag_2S.As_2S_5$.

Enargite is an important copper mineral, especially at Butte, Mont.,[5] where it is in general apparently a primary mineral. Sales thinks that part of the enargite in the upper levels may be secondary, but W. H. Emmons points out that it may be residual.[6] Tower and Smith found enargite to be an original mineral at Tintic, Utah.[7]

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[1] Spurr, J. E., The ore deposits of Monte Cristo, Wash.; U. S. Geol. Survey Twenty-second Ann. Rept., pt. 2, pp. 836–839, 1901.

[2] Emmons, W. H., The enrichment of sulphide ores: U. S. Geol. Survey Bull. 529, pp. 121–122, 1913.

[3] Idem, p. 123.

[4] Weed, W. H., Emmons, S. F., and Tower, G. W., U. S. Geol. Survey Geol. Atlas, Butte special folio (No. 38), p. 6, 1897.

[5] Sales, R. H., Discussion of paper by F. L. Ransome on "Criteria of downward sulphide enrichment." Econ. Geology, vol. 5, p. 681, 1910. Winchell, A. N., Idem, p. 488.

[6] The enrichment of sulphide ores: U. S. Geol. Survey Bull. 529, p. 113, 1913.

[7] Tower, G. W., and Smith, G. O., Geology and mining industry of the Tintic district, Utah: U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 696, 1899.

Epigenite and xanthoconite are rare minerals of whose origin little is known.

The oxyarsenic acids form a part of more than 90 minerals, a much larger number of minerals than those formed in part by sulpharsenic acids, and they are combined with many more elements than are the sulpharsenic acids. In some minerals the arsenic acid radical partly replaces the vanadic acid radical as in the vanadinites, or the phosphoric acid radical as in mimetite, the lead chlorphosphate. As chlorine occurs in these and related minerals, so fluorine is found in durangite, the sodium fluoarsenate. In the arsenical oxyacid minerals are alkali and alkali earth metals, rare earth metals, and zinc, none of which are known in the arsenical sulphacid minerals. Many of the minerals are rather complex and contain several elements, so that there is considerable overlapping of species.

OCCURRENCE OF ARSENIC MINERALS.

As has been stated, arsenic minerals are common in primary ore deposits, and arsenopyrite is probably more plentiful than all other forms together. It is found in schists or gneisses, and in some places forms deposits in them which have been worked for their arsenic content, as at Brinton, Floyd County, Va.[1] It commonly forms in such deposits as shining tin-white, doubly terminated orthorhombic crystals. In small quantity it is common in pegmatites and forms veins with quartz in the crystalline rocks. Most tin veins carry large quantities of arsenopyrite, as do many gold, copper, and mixed sulphide veins, of both deep and moderately deep origin. It is also found in deposits of contact metamorphic origin. Although arsenopyrite is a general component of tin deposits other than those in pegmatites, tin is one of the metals which is not known to form naturally a compound with arsenic.

Veins of arsenopyrite and quartz occur at many places, but only those that carry gold, silver, or other metals in sufficient quantity to make exploitation profitable are worked, the others remaining unworked and almost unknown except in those rare periods when the price of arsenic is high. Veins of arsenopyrite near Pine Pond, town of Kent, Putnam County, N. Y., were worked for arsenic in 1906 and 1907. The material mined was arsenopyrite and subordinate pyrite occurring in quartz veins that cut the country rock (gneiss) near a basic dike that is now altered to serpentine.[2] The vein carries a little copper and is reported [3] to carry some nickel. An arsenopyrite vein has been prospected on Verona Island, in Penobscot River, near Bucksport, Me. Along the east side of Riley Mountain, about 12 miles southeast of Llano, Tex., arsenopyrite occurs in considerable quantity along a fault.[4] Large veins of arsenopyrite are reported to occur in Skagit County, Wash., north of Monte Cristo, and at Monte Cristo [5] arsenopyrite forms a large part of the gangue of the gold veins. Near Covada, Wash., some of the veins carry arseno-

[1] Hess, Frank L., The arsenic deposits at Brinton, Va.: U. S. Geol. Survey Bull. 470, pp. 205–211, 1911.
[2] Newland, D. H., The mining and quarry industry of New York State, Albany, p. 13, 1907.
[3] Personal communication from Kirby Thomas.
[4] Spencer, A. C., Mineral resources of the Llano-Burnet region, Texas: U. S. Geol. Survey Bull. 450, p. 54, 1911.
[5] Spurr, J. E. The ore deposits of Monte Cristo, Wash.: U. S. Geol. Survey Twenty-second Ann. Rept., pt. 2, pp. 836–837, 1901.

pyrite. At Gardner Mountain near Lisbon, N. H., a gold-bearing vein cutting schists carries large quantities of arsenopyrite. Assays are reported to show a content of between 24 and 25 per cent of arsenic in the ores.[1] Many of the gold mines of the country produce a great deal of arsenopyrite, and it is commonly rather rich in gold. In the creek bottom below the mills of the Homestake mine at Lead, S. Dak., there are great quantities of arsenopyrite, which have flowed down the creek with other tailings. The concentrates that are sent to the smelters from some of the Mother Lode mines in California contain much arsenopyrite. Even if the percentage of arsenopyrite in a particular ore is not great, the aggregate quantity handled by the smelters in ores from many mines may become very large. The arsenic in the ore is mostly oxidized, volatilized, and condensed in the fume chambers, where it accumulates.

Great quantities of arsenic are mined at Butte as a constituent of enargite, which is the second copper mineral in abundance in the mines, chalcocite being the most abundant.[2] Harkins and Swain[3] determined that 59,270 pounds of arsenic trioxide were being thrown out of the Anaconda smelter from Butte ores each day, or about 10,800 tons a year. Dunn's estimate[4] in 1911 was 26 tons daily or about 9,500 tons a year, and the total set free from Butte ores is probably 14,000 or 15,000 tons each year.

Arsenic from many minerals passes out of the flues of other smelters. Even in the oxidized lead ores of the Southwest some arsenic occurs in the lead-vanadium minerals vanadinite, descloizite, and cuprodescloizite, in each of which arsenic may replace part of the vanadium; and the phosphorus in mimetite is likely to be replaced by arsenic. In the oxidized copper ores the minerals erinite, olivenite, clinoclasite, tyrolite, chalcophyllite, conicalcite, and other copper arsenates occur sparingly, as at Tintic, Utah.[5] At Tintic, tennantite and enargite occur in the sulphide zone with tetrahedrite and famatinite in which a part of the antimony has been replaced by arsenic. The silver ores of the district contain more or less proustite and with it xanthoconite, pyrargyrite, and polybasite, in which, as in the antimonial copper minerals, arsenic has replaced a part of the antimony. The arsenic in all these minerals makes a rather large aggregate, which must pass through the smelters; and this is especially true of those handling Tintic ores.

It is not possible to estimate closely the quantity of arsenic set free at smelters of the United States other than those which handle Butte copper ores, but as practically all ores except the lead and zinc ores of the Eastern and Central States carry some arsenic, the total outside of the Butte ore smelters may be 5,000 or 6,000 tons a year, so that the total arsenic trioxide in the smelter fumes of the United States possibly amounts to 20,000 tons a year, exclusive of the quantities now saved. The installation of Cottrell devices for settling flue dusts

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[1] Letter of John Alley Parker, Apr. 27, 1915.

[2] Weed, W. H., Geology and ore deposits of the Butte district, Mont.: U. S. Geol. Survey Prof. Paper 74, p. 77, 1912.

[3] Papers on smelter smoke. The determination of arsenic and other solid constituents of smelter smoke, with a study of the effects of high stacks and large condensing flues: Am. Chem. Soc. Jour., vol. 29, p. 994, 1907.

[4] Dunn, E. M., Determination of gases in smelter flues; and notes on the determination of dust losses at the Washoe Reduction Works, Anaconda, Mont.: Am. Inst. Min. Eng. Trans., vol. 46, pp. 687–688, 1914.

[5] Tower, G. W., and Smith, G. O., Geology and mining industry of the Tintic district, Utah: U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, pp. 691–692, 1899.

will probably add very greatly to the arsenic trioxide collected and probably to that saved.

The only other arsenic minerals which occur in quantities large enough to tempt exploitation for arsenic are orpiment and realgar. These are said to occur on Mineral Creek, near Mineral, in Lewis County, Wash., in considerable quantity, and at one time a plant was erected to work them, but little arsenic trioxide was produced.

Deposits of realgar with a little orpiment are reported to occur near Clark Lake, Skagit County, Wash. In a specimen of crushed, leached, and silicified igneous rock sent to the Survey the realgar fills small cracks and cavities, some of which may have been occupied by arsenopyrite. The deposit is described as large.

Beautiful specimens of realgar with less orpiment have been sent to the Survey from Alaska. One deposit was described by George J. Shoup as "a little west of north of Tick Chick Lake, on the divide between Nushigak Bay and Kuskokwim River, a little above Bethel." Stibnite is said to occur in a parallel vein in the same deposit. The deposits are in a granitic rock, probably granodiorite. Another specimen was sent from the same general region, but whether from the same deposit is not clear.

Deposits in Yellowstone Park and near Coyoto, Utah, have already been mentioned.

Realgar in small quantity occurs with stibnite and gold in the White Cap and other mines at Manhattan, Nev.[1]

OTHER RESOURCES.

Should need arise, considerable supplies of arsenic may be obtained as by-products from materials shipped to this country for some content other than arsenic, and from various domestic sources not before mentioned. Great quantities of pyrite are imported from Rio Tinto, Spain, for making sulphuric acid. This pyrite, although considered very pure, contains from 0.21 to 0.83 per cent of arsenic,[2] equivalent to 0.28 to 1.1 per cent of arsenic trioxide. The larger part of this arsenic goes over into the acid, and if the acid is desired for purposes to which arsenic is inimical it is precipitated by sulphuretted hydrogen in the form of orpiment, $As_2 S_3$, and filtered out by passing the acid through sand. The Pennsylvania Salt Manufacturing Co. has thus accumulated at its plant at Natrona, Pa., several thousand tons of orpiment. Other firms, which use their acids for fertilizers and like purposes, do not separate the arsenic. In at least a part of the refineries arsenic is simply separated from the electrolyte in electrolytic copper refining, but as there is no market for the material, it is allowed to flow away with the sewage. At present this orpiment has no commercial value, but some use may be found for it.

Many foreign ores, which are imported into this country for smelting, such as the silver ores of Cobalt, Ontario; gold, silver, and other ores from western Canada; and copper ores from various other countries, carry in the aggregate a large quantity of arsenic. Whether it is saved or not depends upon the practice at the smelter to which

[1] Communicated by H. G. Ferguson.

[2] Beyschlag, F., Vogt, J. H. L., and Krusch, P., The deposits of the useful minerals and rocks; their origin, form, and content, trans. by S. J. Truscott, p. 323, London, 1914.

it goes. Practically all blister copper sent to the electrolytic refineries carries arsenic in quantities ranging from less than 0.05 per cent to 2 per cent. Part of this is eliminated in anode-furnace treatment, part goes into the anode slimes, and part, as arsenious acid, goes into the electrolyte.[1] None is known to be saved. It is probably safe to estimate that 5,000 or more tons of arsenic from these sources is unused each year.

The arsenic resources of the country are immense and the quantities available as by-products are so far beyond its present capacity for use that it would not be fair to say that this unused arsenic is wasted, but probably a total of at least 25,000 tons of white arsenic could be saved each year as a by-product.

PRODUCTION.

White arsenic was not produced in the United States until 1901, when the Puget Sound Reduction Co., at Everett, Wash., made an output of 300 short tons, saved as a by-product in smelting gold and silver ores. The production to date is shown below:

Production of white arsenic, As_2O_3, 1901–1914, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1901	300	$18,000	1908	(a)	(a)
1902	1,353	81,180	1909	1,214	$52,946
1903	611	36,691	1910	1,497	52,305
1904	36	2,185	1911	3,132	73,408
1905	754	35,210	1912	3,141	190,757
1906	737	63,460	1913	2,513	159,236
1907	1,751	163,000	1914	[b] 4,670	313,147

a Only two firms produced arsenic in the United States in 1908, so that the figures can not be published without disclosing confidential returns.
b This quantity includes 200 tons of crude arsenic trioxide carrying about 97.5 per cent As_2O_3.

The refined arsenic produced is reported to be above 99.5 per cent pure. Not all of the arsenic refined in 1914 was sold, for the market was unable to absorb both the domestic and the imported material.

PRICES.

The prices of arsenic during 1914, as reported to the Survey, ranged from 2.9 cents to 3.6 cents a pound on board the cars at the works. The price of white arsenic during the year, as shown by the file of the Oil, Paint, and Drug Reporter, ranged from 2⅞ cents a pound at the beginning of the year to 5 cents at the end of July. After the European war began the price rose, reaching 5½ or 6 cents in September, from which it gradually declined to 3⅞ cents at the close of the year. The low price of arsenic which has generally prevailed is shown by the following table of imports, giving quantities and declared values from 1868 to 1914 and the prices deduced therefrom.

[1] Pyne, F. R., Arsene formation in electrolytic refining: Eng. and Min. Jour., vol. 98, p. 432, 1914.

Imports of arsenic compounds since 1868.[a]

Year.	Quantity.	Value.	Price per pound.	Paris green and London purple.	
				Quantity.	Value
Fiscal year:	*Short tons.*		*Cents.*	*Pounds.*	
1868	721	$19,191	1.33		
1869	721	29,450	2.04		
1870	283	12,463	2.23		
1871	665	29,822	2.24		
1872	555	30,337	2.73		
1873	381	22,367	2.94		
1874	888	47,393	2.67		
1875	1,216	53,582	2.20		
1876	254	16,642	3.28		
1877	1,297	71,969	2.78		
1878	1,247	57,213	2.30		
1879	1,241	53,631	2.16		
1880	1,360	62,357	2.29		
1881	1,113	54,056	2.42		
1882	1,724	91,396	2.65		
1883	2,805	139,513	2.49		
1884	1,847	83,316	2.26		
1885	1,684	85,782	2.55		
1886	2,521	101,371	2.01		
1887	1,795	78,883	2.20		
1888	3,555	163,645	2.30		
1889	4,352	220,596	2.54		
1890	4,248	229,109	2.70		
1891	2,672	161,367	3.02		
1892	2,467	124,027	2.50		
1893	3,664	207,516	2.83		
Calendar year:					
1893	3,046	180,333	2.96		
1894	3,532	218,636	3.10		
1895	3,492	237,747	3.40		
1896	2,907	215,281	3.71		
1897	3,621	352,284	4.87		
1898	4,343	370,347	4.26		
1899	4,520	386,791	4.28		
1900	2,883	265,500	4.61		
1901	3,495	316,525	4.53		
1902	4,055	280,055	3.46		
1903	4,179	294,602	3.53		
1904	3,400	243,380	3.58	28,498	$985
1905	3,838	256,540	3.34	44,931	1,118
1906	3,987	350,045	4.39	311,293	21,347
1907	5,164	574,998	5.52	133,422	21,919
1908	4,964	430,400	4.34	195,000	30,764
1909	4,036	303,728	3.76	183,765	20,370
1910	5,139	314,306	3.06	181,363	14,648
1911	4,096	247,323	3.01	126,191	4,972
1912	6,156	428,741	3.48	162,272	6,950
1913	4,701	410,446	4.37	99,692	4,431
1914	3,628	273,713	3.77	15,476	2,235

[a] Figures taken from "Imports and exports, Part I; Imports from 1867 to 1893, inclusive," by Charles H. Evans, S. Rept. No. 259, 53d Cong., 1894; "Imports and duties, 1894-1907," by William W. Evans, Washington, 1908; and from the records of the Bureau of Manufactures and Commerce. The records to 1893 are given by fiscal years, ending June 30. From 1868 to 1872 they give only "arsenic" imports; from 1873 to 1883 both "arsenic" and "arsenious acid," except in 1881, when no imports of arsenious acid are shown; from 1884 to 1893 only "arsenic"; from 1893 to 1912, inclusive, "arsenic or arsenious acid" and "arsenic and sulphide of, or orpiment," which, owing to the uncertainty of the articles entered under these terms, have been combined. During the last 10 years white arsenic and probably true arsenic acid have been imported under the head of "arsenic or arsenious acid." So far as can be learned, elemental arsenic, both orpiment and realgar, white arsenic, and possibly other compounds, are included under "Arsenic and sulphide of, or orpiment." No figures showing imports of Paris green and London purple before 1904 are available.

The prices given are, of course, composites and are not exact for any arsenic compound, but they show the relative prices for the last 48 years with sufficient accuracy to permit a fair general comparison of the prices from year to year and to indicate their trend. The values given for 1911 in particular are probably too high and those for 1912 are probably low.

FOREIGN PRODUCTION.

The plants in the United States that produce white arsenic are in the West, and the markets are along or near the eastern seaboard. The domestic product must therefore compete with arsenic made in foreign countries, in which the plants are near the coast, and so can ship cheaply to this country by water, and with arsenic produced in Canada at plants that are nearer than the domestic plants to the eastern markets.

The white arsenic made in Canada, like that of the United States, is a by-product. In 1913 it was saved by smelters at Thorold, Copper Cliff, and Orillia, Ontario, from the arsenical silver ores from Cobalt, Ontario, which were treated at these plants, and white arsenic was presumably produced at the same plants in 1914. The production of white arsenic in 1913 [1] was 1,692 tons, valued at $101,463, and in 1914 [2] was 1,737 tons.

White arsenic is produced in Mexico at the smelter of the Compañía Minera de Peñoles, at Mapimi. This plant is owned by the American Metal Co.

The world's production of arsenic in 1911–12 is shown by the table below. The figures—except for the United States and those otherwise credited—are taken from the British Home Office's "Mines and quarries: General report with statistics for 1912, Part IV."

World's production of arsenic, 1911–12, by countries, in short tons.

	1911		1912	
	Quantity.	Value.	Quantity.	Value.
Great Britain:				
Arsenopyrite			1,310	$6,276
Arsenic			2,401	70,124
Canada [a]	2,097	$76,237	2,045	89,262
China:				
Exports	246		186	
Orpiment—exports [b]	366	23,138	377	21,635
France (arsenopyrite) [c]				
Germany (arsenic ore)	5,356	105,084	24,369	656,775
Japan (metal)	7	384		
Mexico [d]	2,000		2,000	
Portugal	987	38,356	1,047	45,416
Spain (arsenopyrite) [e]	1,164	34,931		
United States	3,132	73,408	3,141	190,757

[a] McLeish, John, Annual report on the mineral production of Canada during the calendar year 1913. Ottawa, p. 191, 1914.

[b] "Orpiment, yellow sulphide (As_2S_3), is obtained from mines near Chaochow and Menghua, in the Tali prefecture, about 24 miles from Hsia Kuan, in the province of Yunnan. In 1912, 273 metric tons (301 short tons) were exported from Teng Yuek and 69 tons (75 short tons) from Mengtsz." The exports as given in the Reports of the Maritime Customs of China give no orpiment, but call it realgar. (See p. 963.)

[c] Large quantities of arsenical gold ore—in 1912, 165,380 metric tons, valued at 9,574,000 francs, and in 1911 162,499 metric tons, valued at 8,055,000 francs—were mined in France, but no statement is made of the quantity of white arsenic in the ore or saved. See Statistique de l'industrie minérale et des appareils à vapeur en France et en Algérie pour l'année 1912, Paris, pp. 32 and 34, 1914.

[d] Estimate, Mineral Industry, 1912, p. 45.

[e] Mineral Industry, 1913, p. 32, gives Spain credit for 331 metric tons of white arsenic in 1911.

The figures are not very satisfactory, but it appears that the world's output of arsenic in 1912 was equivalent to between 10,000 and 15,000 tons of white arsenic.

[1] McLeish, John, Annual report on the mineral production of Canada during the calendar year 1913, p. 191, Ottawa, 1914.

[2] Preliminary report on the mineral production of Canada, 1914.

Although native realgar and orpiment are not produced in this country, small quantities of realgar are imported and considerable quantities are mined in China. Little is known of the Chinese occurrences, but the Hunan realgar, which is exported through Changsha, is said to be found near Tzu-li, west of Tungting Lake and northwest of Changsha, at the north side of a general area containing many veins of stibnite.[1] A considerable quantity of white arsenic is produced in the same area. The shipments of realgar and white arsenic from China in 1913 were 859 and 484 short tons, respectively.[2]

Orpiment is mined in India near the village of Lower Tirich, Chitral.[3]

USES.

White arsenic is used principally in glass making, which consumes about half the domestic output. Some say that it forms arsenides with iron and other impurities and causes them to settle to the bottom of the melt, but apparently its use in making window glass in tanks has almost if not entirely ceased in the United States, for, it is said that, owing to the larger size of the tanks, the impurities settle without the use of arsenic. It is used in most pot furnaces, but in many of them it is being replaced by antimony oxide and "needle antimony" (liquated stibnite). Some flint-glass factories use none and no substitute; others use as much as 60 tons of white arsenic a year. A few factories use arsenic sulphide (orpiment, As_2S_3) instead of white arsenic. The plate-glass factories use large quantities of white arsenic, the consumption of a single firm reaching 5 tons a month, or between 50 and 60 tons a year. Glassmakers who have studied the subject carefully say that arsenic apparently enters directly into the composition of the glass and probably tends to make it clear.

A great quantity of arsenic and arsenate of soda is now used in making Paris green and lead arsenate, and in less quantity in making other compounds for insecticides. With the growth of horticulture and the necessarily greater attention paid to killing insect pests, the demand for arsenical insecticides has grown immensely.

Orpiment seems to be used mostly in textile dying and was once much used in removing hair from skins to be made into leather, but is being replaced by other compounds.

Elemental or "metallic" arsenic is used, so far as is known, only in shot making, and only a few tons, probably 5 to 10 a year, are consumed. It is said to make the shot rounder and harder. According to Outing (November, 1915), arsenic is in part replacing antimony in making "chilled shot," on account of the increased price of antimony due to the European war. Several hundred tons of white arsenic is used annually for killing weeds along railroad tracks, for which use the crude arsenic trioxide is cheaper and nearly as serviceable as the refined. Water hyacinths in Gatun Lake, Panama, were poisoned by spraying with a solution made of 25 pounds of arsenic, 25 pounds of soda, and 25 gallons of water boiled together for an hour and then mixed with 425 gallons of water.[4] Arsenic is being experimented with for use in nonfouling paints for ship bottoms.

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[1] Giles, Lancelot, Report on the trade of Changsha for the year 1913: Diplom. and Cons. Repts. No. 5298, Ann. Ser., Foreign Office, London, 1914.
[2] Returns of trade and trade reports, 1913: The Maritime Customs, China, 1914.
[3] Kennion, R. L., Sport and life in the further Himalaya, pp. 144–145, 1910.
[4] Min. and Sci. Press, June 13, 1914, p. 984.

Most of the arsenic used for the purposes stated is of course unrecoverable; it is not subject to the secondary recovery practiced with tin, lead, iron, and other metals.

FIELD TESTS FOR ARSENIC.

When arsenopyrite is struck with a hammer it gives off an odor somewhat like garlic—the "alliaceous odor" of the textbooks—an odor familiar in mines where drills are cutting rock or ore impregnated with arsenopyrite. If arsenopyrite, enargite, cobaltite, smaltite, safflorite, niccolite, or similar arsenical minerals are heated in the air they give off the same odor much more freely. The sulphur-bearing arsenic minerals give off first the familiar odor of sulphur dioxide, then the garlic-like odor. If heated in a closed tube the arsenides give a yellow ring, probably of arsenic sulphide, and nearer the assay a ring of dark, silvery elemental arsenic so dense that it gives a mirror effect. This is the "arsenic mirror" and it shows beautifully the metallic luster of the element.

Enargite gives a ring of yellow arsenic sulphide but no mirror. A nickel-arsenic antimony sulphide, possibly to be classed as arite, gives in the closed tube, toward the cool end, a yellow arsenic sulphide ring, nearer the assay an arsenic mirror, and nearest the assay a dull red ring, which is probably antimony sulphide.

BISMUTH.[1]

By Frank L. Hess.

PRODUCTION.

So far as is reported to the Geological Survey, bismuth ores were produced and sold as such during 1914, from only one mine in the United States, the Wilson Consolidated Mining Co., which shipped one lot of oxidized bismuth ore from its mine in the Clifton district, Deep Creek Mountains, Tooele County, Utah. The ore carried also gold and silver and was sold late in the year, when prices were high.

The only bismuth produced in the United States was obtained as a by-product in refining lead bullion by the United States Metals Refining Co., at Grasselli, Ind., and by the American Smelting & Refining Co., at Omaha, Nebr. Some residues rich in bismuth were saved in corroding lead by the National Lead Co., and by the Matheson Lead Co., but none were sold.

Oxidized bismuth minerals are reported by Clyde M. Becker, of Hanover, N. Mex., and L. B. Bentley, of Organ, N. Mex., as occurring on a number of claims in the Organ Mountains, among others the Texas Canyon mine and the Memphis mine at Organ, where bismuth occurs with copper minerals and the ores shipped are said to average 1 per cent bismuth.

Bismuth has also been reported in the ores from the Torpedo, Excelsior, Stephenson-Bennett, and Quickstrike mines at Organ; in veins that cut granite on San Augustine Peak; and in veins and other copper lead deposits in San Andreas Range as far north as Salinas Peak. The bismuth deposits, 35 miles southeast of Tularosa, N. Mex., which have been noted several times in these reports and from which a small production has been made, are apparently at the north end of this belt of bismuth-bearing deposits. Wulfenite (lead molybdate) occurs with the bismuth ores at several places. Very little of the bismuth in the ore has been paid for.

R. H. Servant, Golden, Colo., reports that he has a bismuth deposit near Aspen, Colo., and that some prospecting has been done upon the claim.

In September, 1914, announcement was made that a considerable quantity of oxidized bismuth ore had been found on the 600-foot level of the Mammoth mine at Tintic, Utah. Officers of the company stated to Victor C. Heikes that a face 18 inches wide had given an assay of 16.2 per cent bismuth, 5.7 per cent copper, and 0.88 ounce of gold and 121.6 ounces of silver per ton. A yellow streak 16

[1] Chemical symbol, Bi.; atomic weight, 208; specific gravity, 9.67–9.90; melting point, 270° C.

inches wide gave 18.12 per cent bismuth and 2.6 per cent copper, and 0.64 ounce of gold and 153.7 ounces of silver per ton. A picked sample of yellow ore carried 32 per cent of bismuth, and some green copper-bearing material carried 2.08 per cent bismuth, and 19.3 per cent copper, and 1 ounce of gold and 44.5 ounces of silver per ton.

From the Opohongo mine at Tintic, Utah, 74 lots of ore, aggregating 4,099 tons, were shipped in 1910. The ore averaged 0.28 to 0.6 per cent bismuth, 2.08 to 4.35 per cent arsenic, 0.2 to 0.75 per cent antimony, 7.5 per cent iron, 3.5 per cent lime, and 0.926 ounce gold and 7.96 ounces silver per ton.

The quantities produced in 1911 and 1912 were probably about the same, and though assays for the base metals were not regularly made, they are said to have run about the same. Figures for 1911 and 1912 are not at hand. Both the Mammoth and Opohongo mines are worked for gold, silver, and copper.

Bismuth minerals are also found in the Eagle, Blue Bell, Boss Tweed, Carisa, Emerald, Victoria, and other mines at Tintic, Utah. The principal metal in the ores of the first two mines is lead; in the others it is copper.

The Tintic ores go to smelters in Utah. The United States Metals Refining Co. has depended largely upon the lead ores of Tintic for the bismuth which it saves at its electrolytic lead refining plant at Grasselli. Part of the ores go to the Garfield smelter, and as that plant has installed the Cottrell fume-condensing system, bismuth will probably be recovered from fumes as well as from lead bullion of other plants.

The only available figures showing the quantity of bismuth carried in fumes from smelters relate to the Washoe smelter at Anaconda. The Anaconda Copper Co. has happily allowed the publication of the results of important work done first by Harkins and Swain [1] and later by Dunn,[2] whose figures confirm those obtained by the earlier work. The smelter treats Butte copper ores, and in 1911 the dusts caught in the flues (76.8 tons a day) carried 1.15 per cent of bismuth trioxide, Bi_2O_3, equivalent to 1.03 per cent of bismuth, about three-fourths of a ton a day, or 275 tons a year. However, though the dusts carry 20 pounds of bismuth per ton, worth during 1913 at least $35 (the New York market price was $1.75 to $2.25 a pound), Dunn concludes that it is not worth saving. Late in 1914 the prices were much higher, reaching $2.75 or $3.00 a pound. It seems safe to predict that if prices remain as high as they have been during the last few years, a process will be devised for obtaining bismuth from flue dust as rich as this. Probably the larger part of the bismuth in copper ores goes out through the smelter stacks. A table given by Eilers [3] shows recoveries of bismuth from blister copper, when refined electrolytically, ranging from one-third of a pound to the hundred tons of blister copper from Steptoe, Nev. (Ely ores), to 27.3 pounds from the blister copper from Mountain, Cal. (Iron Mountain ores).

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[1] Harkins, W. D., and Swain, R. E. Papers on smelter smoke: The determination of arsenic and other solid constituents of smelter smoke, with a study of the effects of high stacks and large condensing flues: Am. Chem. Soc Jour., vol. 29, pp. 992–994, 1907.

[2] Dunn, E. M., Determination of gases in smelter flues, and notes on the determination of dust losses at the Washoe reduction works, Anaconda, Mont.: Am. Inst. Min. Eng. Trans., vol. 46, pp. 648–689, 1914.

[3] Eilers, Anton, Notes on some of the rarer metals in blister copper: Am. Inst. Min. Eng. Trans., vol. 47, pp. 217–218, 1914.

With the adoption of the Cottrell process of fume precipitation at Garfield and other smelters another large potential source of bismuth is being provided; and should it prove feasible to separate the bismuth from the mass of dust and fume, enough bismuth may be produced to supply the present American market entirely and possibly to provide for larger markets, developed by cheaper bismuth. The quantity of bismuth now produced in this country is comparatively large and has apparently made a considerable difference in the imports, but the conditions of saving have not made a better market for the miner, because the bismuth has been wholly a by-product, nor has the price been reduced to the consumer, possibly for reasons quite as good. Possibly bismuth is being saved at some of the electrolytic refineries, though none has been reported to the Survey.

Among the lesser possible sources of bismuth is placer gold from some localities in Alaska and pucherite, a bismuth vanadate, found in small quantity in San Domingo Wash, near Hot Springs Junction, Ariz.[1]

IMPORTS.

During 1914, according to figures obtained from the division of statistics, Bureau of Foreign and Domestic Commerce, 90,505 pounds of metallic bismuth, valued at $165,208, were imported for consumption, a quantity less than half as large as the average for the nine years previous to 1913, when the domestic production first seriously cut into the imports.

Imports for consumption of metallic bismuth into the United States, 1905–1914, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1904	185,905	$339,058	1910	198,174	$332,668
1905	148,589	318,007	1911	172,093	311,771
1906	254,733	318,452	1912	182,840	316,440
1907	259,881	325,015	1913	117,747	213,257
1908	164,793	257,397	1914	90,505	165,208
1909	183,413	286,516			

In 1913 Bolivia [2] produced 861,134 pounds of bismuth ore, valued at $774,781; Queensland,[3] 205,500 pounds, valued at $46,482; Peru,[4] 55,786 pounds of metal, valued at $46,198; Tasmania,[5] 12,379 pounds of ore, valued at $7,917; New South Wales,[6] 19,488 pounds of ore and metal, valued at $5,850. Figures for the output of Spain and Saxony in 1913 are not available, but in 1912, Spain [7] produced 160,965 pounds of ore, valued at $1,801, and Saxony [8] produced 7,145 pounds of refined metal, valued at $12,763.

[1] Letter from Dr. Burt Ogburn, State dentist.
[2] Figures furnished by Pan-American Bureau, Washington, D. C.
[3] Queensland Government Min. Jour., Brisbane, vol. 15, p. 125, March, 1914. The figures as given are: Bismuth, 1 long ton, 12 cwt.; bismuth and wolfram, 181 long tons, 15 cwt. For convenience, the bismuth-wolframite mixture is treated as being half bismuth ore, as no figures are given to show the exact content. One-half the value also is taken.
[4] Jiménez, Carlos P., Estadística minera del Perú en 1913: Cuerpo Ing. Minas Perú Bol. 81, p. 11, 1915. As given the figures are bismuto (fino) 25,300 kilogramos, valor, libras 9,492.
[5] Report of the secretary for mines for year ending Dec. 31, 1913, Hobart, 1914.
[6] New South Wales Dept. Mines Ann. Rept. 1913, p. 63, 1914.
[7] Min. Jour. [London], May 23, 1914, p. 497. Figures for 1912 are the latest available.
[8] Jahrbuch Berg- und Hüttenwesen im Konigr. Sachsen, 1913 (Statistik vom Jahre 1912), p. B252, Freiburg, 1913.

USES.

Bismuth is not a widely useful metal. Its brittleness prevents its use for anything which should be tough or malleable. It expands on solidifying from the molten condition, and on account of this property it has sometimes been used in type metal. It is used chiefly in medicine, for which it furnishes a considerable number of salts. Bismuth nitrate is sometimes given internally when roentgenographs are to be made of the abdominal region, as bismuth salts are opaque to the Roentgen rays. Bismuth is extensively used in low melting point or cliché alloys, such as are used in the automatic sprinklers placed as a protection against fire in warehouses and stores, in fuses for electric wiring, and in solders. Its use in storage batteries is said to be prevented by its high price. Its salts have been used in face powders, as their smoothness is very grateful, but they are said to darken in atmospheres containing sulphur, so that this use is largely discontinued. A little is used in some bearing metals.

SELENIUM.[1]

By Frank L. Hess.

OCCURRENCE.

Selenium was discovered by Berzelius in 1817 in a deposit in the lead chambers of a sulphuric acid plant at Gripsholm, Sweden. The acid was made from sulphur that had been distilled from Falun sulphides—mostly pyrite, though including a little copper, lead, zinc, and tin sulphide and probably some arsenopyrite. Selenium is still obtained as a by-product, though from sources not at that time known—the anode muds formed in the electrolytic refining of copper.

Selenium, as ordinarily placed on the market, is an amorphous brilliant black substance looking much like pitch or one of the asphalts. In very thin fragments it is translucent and ruby red, and in fine powder it is reddish. It is sold in small pigs, in sticks half an inch thick and about 4 inches long, and in a fairly coarse powder. It is soluble in carbon bisulphide.

Selenium may be obtained as a red crystalline substance including, perhaps, two closely allied forms,[2] also soluble in carbon bisulphide. A third form, metallic selenium, is insoluble in carbon bisulphide,[3] and is the stable form.[4] Metallic selenium conducts electricity when exposed to light, but when the light is cut off its electrical resistance is greatly increased.

Selenium is one of the rare elements. Beyschlag, Krusch, and Vogt,[5] estimate that it forms about 0.0002 per cent of the known rocks. This may be compared with estimates by the same authors of 4.5 per cent of iron, 0.001 per cent lead, 0.001 per cent zinc, and 0.0000001 per cent of gold. It is possibly too high.

As would be supposed from these figures, minerals carrying selenium are uncommon and are found only in small quantities. The following selenium minerals are listed by Dana: [6]

Selensulphur, that is, native sulphur containing selenium in unknown proportions, has been found on the islands of Vulcano and Lipari. Seleniferous sulphur has also been found at Kilauea, Hawaii, and in Japan.

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[1] Chemical symbol, Se; atomic weight, 79.2; specific gravity: liquid or amorphous form 4.26, metallic form 4.8; melting point: The amorphous form becomes soft at 40° to 50° C., the red crystalline form melts at about 170° C., metallic selenium melts at 217° C.

[2] Saunders, A. P., The allotropic forms of selenium: Jour. Phys. Chem., vol. 4, p. 428, 1900.
Roscoe, H. E., and Schorlemmer, C. (A treatise on chemistry, vol. 1, p. 467, 1911), state that red selenium crystalli. es in two forms.

[3] Roscoe and Schorlemmer, idem, pp. 467–469.

[4] Saunders, A. P., op. cit., p. 429.

[5] Die Lagerstätten der nutzbaren Mineralien und Gesteine, nach Form, Inhalt und Entstehung, vol. 1, 2d ed., p. 157, 1914.

[6] System of mineralogy, 6th ed., 1909. No new selenium minerals are noted in Appendixes I, II, or III.

Selen-tellurium is a native compound of selenium and tellurium in the ratio of about 3 to 2. It has been found in the El Plomo silver mine, Ojojona district, Tegucigalpa, Honduras.

Clausthalite, PbSe, lead selenide, contains 27.7 per cent of selenium. A small specimen has been sent to the United States National Museum from Montana by J. P. Rowe, who gave no locality.

Tilkerodite is a cobalt-bearing variety of clausthalite. It is unknown in this country.

Zorgite is a selenide of lead and copper, which may be only an impure clausthalite.

Naumanite, (Ag_2, Pb) Se, a selenide of silver, or of silver and lead. If pure AgSe, it would contain 26.8 per cent of selenium. It has not been recognized in the United States.

Berzelianite, Cu_2Se, copper selenide, contains 38.4 per cent of selenium. Berzelianite is not known to have been identified in this country. Berzelianite or some similar mineral probably furnishes the selenium found in many copper ores.

Lehrbachite, PbSe with HgSe, selenide of lead and mercury, contains 24.4 to 25.0 per cent of selenium. It is not known in the United States.

Eucairite, $Cu_2Se.AgSe$, selenide of copper and silver, contains 31.6 per cent of selenium. It is not known in the United States.

Crookesite (Cu,Tl,Ag) Se, a selenide of copper and thallium with a small quantity of silver, has been noted only at Skrikerum, Sweden.

Aguilarite, $Ag_2S.Ag_2Se$, silver sulphoselenide, has been found at Guanajuato, Mexico.

Guanajuatite, Bi_2Se_3, bismuth selenide, found also at Guanajuato, Mexico, contains 36.3 per cent of selenium.

Tiemanite, HgSe, mercury selenide, contains 28.3 per cent of selenium. Tiemanite and onofrite were at one time found in considerable quantity near Marysvale, Piute County, Utah. The vein was at one place 4 feet thick,[1] but it has been removed so completely that even small specimens are now difficult to get. So far as known, this is the only deposit that has been worked for selenides alone. No selenium was saved, however,

Onofrite, Hg (S, Se), mercury, sulpho-selenide, contains 4.7 to 6.6 per cent of selenium. Onofrite occurred with the tiemanite at Marysvale, Utah, and, according to McCaskey,[2] formed the greater part of the ore minerals.

Small quantities of selenium are found in some other minerals, among which are guadalcazarite, a variety of metacinnabarite including also a little zinc, and the closely related mineral leviglianite, containing some iron. Some tellurides contain also a small quantity of selenium, which plays the part ordinarily played by tellurium, to which selenium is very closely related in chemical properties. The reported occurrence of selenium in pyrite and chalcopyrite may be due to the presence in these minerals of selenide of copper or other selenides in minute quantities rather than, as has been suggested, to the replacement of sulphur by selenium.

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[1] Becker, G. F., Geology of the quicksilver deposits of the Pacific Slope: U. S. Geol. Survey Mon. 13, pp. 385–386, 1888. McCaskey, H. D., Quicksilver in 1911: U. S. Geol. Survey Mineral Resources, 1911, pt. 1, pp. 914–915, 1912.

[2] Op. cit.

PRODUCTION.

As already stated, the commercial supply of selenium is furnished by the electrolytic copper refineries. Nearly all, if not all, blister copper sent to the electrolytic refineries contains some selenium, and while the anodes are wasting away the selenium, with tellurium, gold, silver, and other impurities, drops to the bottom of the tanks, forming the anode slimes or muds. The quantity of selenium contained in certain blister coppers is shown in the following table:

Selenium recovered from 100 tons of blister copper.[a]

Smelter supplying blister copper.	Selenium.	Smelter supplying blister copper.	Selenium.
	Pounds.		*Pounds.*
Garfield, Utah	56	Tacoma, Washington	42
Steptoe, Nevada	110.1	Aguascalientes, Mexico	170
Omaha, Nebraska	26.6	Cerro de Pasco, Peru	13.7
Mountain, California	36	Mount Lyell, Tasmania	42

[a] Eilers, A., Notes on the occurrence of some of the rarer metals in blister copper: Am. Inst. Min. Eng. Trans., vol. 47, pp. 217–218, 1914.

Eilers comments as follows:

Garfield, Utah. The blister copper comes principally from the Bingham porphyry copper mines.

Steptoe, Nev. All the blister copper is produced from the Nevada Consolidated mines. (Also porphyry deposits.)

Omaha, Nebr. Blister copper comes principally from concentrated copper-lead mattes shipped from the different lead-silver plants of the Rocky Mountain region to the converters at the Omaha lead refinery.

Mountain, Cal. Ores occur in connection with diorite (?).

Tacoma, Wash. The blister is produced from Pacific coast and Alaska copper ores, all of which occur in connection with diorite dikes and masses.

Aguascalientes, Mexico. Blister is produced from the smelting of silver and gold ores with mostly low-grade copper ores, coming from all parts of Mexico and from many different geological occurrences and connections.

Cerro de Pasco, Peru. Blister from copper and lead-copper mattes produced at the Cerro de Pasco works. Ore originates in veins occurring in limestone near andesite masses.

Mount Lyell, Tasmania. Blister is from the well-known low-grade copper deposit of Tasmania. The geological occurrence is not known to me.

As the Butte mining district produces more copper than any other copper-mining district, some interest attaches to figures concerning the selenium content of the Butte blister copper. Edward Keller[1] states that in 1897 the average Butte matte contained 60 per cent of copper and 0.01 per cent of selenium and tellurium. The ratio of selenium to tellurium ranged from 1 : 1 to 1 : 3. He also states that 95 per cent of the selenium and tellurium was lost in bessemerizing the matte. These figures would indicate less than a pound of selenium in 100 tons of blister copper made from Butte ores. The percentage of selenium and tellurium in the ores is thought to be about one-tenth of that in the mattes, or 0.001 per cent, of which one-half, say 0.0005 per cent, is selenium; in other words, the ores contain only minute traces of selenium, and its form is wholly unknown, not only at Butte but in other copper camps. In a later article[2] Keller states that copper bullion that presumably came

[1] Quoted by Weed, W. H., Geology and ore deposits of the Butte district, Mont.: U. S. Geol. Survey Prof. Paper 74, pp. 70–71, 1912.

[2] Some recent American progress in the assay of copper bullion: Am. Inst. Min. Eng. Trans., vol. 46, p. 768, 1914.

from Butte carries 0.0072 per cent selenium and tellurium. If the ratio of 1 to 1 holds, then the copper bullion carries about 7.2 pounds of each per 100 tons, a quantity considerably below the recoveries shown in Eilers's table. F. L. Antisell, of the Raritan Copper Works, in a letter to the Survey, states that copper received from Butte during 1914 contained the percentages of other metals shown as follows:

	Se	Te	Ni	Bi
Anaconda	0.001	0.014	0.011	0.002
Great Falls	.004	.019	.034	.006

The ratios of selenium to tellurium are about 1 to 14 and 1 to 5, or 2 and 8 pounds of selenium and 28 and 38 pounds of tellurium per 100 tons of blister copper. According to Antisell the quantity of selenium in the blister copper from Anaconda, 0.001 per cent, is about twice that which Keller thought was present in the ores, so that a very considerable quantity must have gone either into the stack or into the slags. As both selenium and its oxides are very volatile, it probably went through the stack.

The difference in the selenium content of the blister copper from the two smelters appears to be wholly due to furnace treatment. The Anaconda copper is poured from the converter into a refining furnace. The Great Falls copper is poured from the converter into slab molds. The Anaconda copper carried 99.31 per cent of copper, the Great Falls 99.25 per cent. So far as is known, there is no particular difference in the ores, all of which are mined in Butte.

It is peculiar that even a small part of this very easily volatilized element should cling to the copper throughout the high temperatures and oxidizing atmospheres in which the copper is treated. Keller's figures,[1] however, show that probably 20 times as much is lost in the various processes. Dunn found no selenium in the flue dusts[2] passing the base of the big stack at Anaconda, though undetermined quantities of selenium and tellurium oxides were found in both reverberatory and main flues.[3] Harkins and Swain at one time found 0.027 per cent selenium and 0.016 per cent tellurium in the flue dusts of the same smelter.[4] These percentages indicate 54 pounds of selenium and 32 pounds of tellurium to each 100 tons of flue dusts, more selenium than tellurium, although blister copper shows from 2 to 8 pounds of selenium and 28 to 38 pounds of tellurium. These figures indicate that in the smelter selenium is much more completely and easily driven off than tellurium.

The anode slimes in the copper refineries contain a large percentage, at times 50 per cent or more, of gold and silver. The slimes are treated in very large cupellation furnaces, as large as the reverberatory furnaces which a few years ago were used for copper smelting. Selenium is collected in the flue dusts from this cupellation, and is recovered by processes which differ with the refinery.

[1] Quoted by W. H. Weed, op. cit.

[2] Dunn, E. M., Determination of gases in smelter flues; and notes on the determination of dust losses at the Washoe Reduction Works, Anaconda, Mont.: Am. Inst. Min. Eng. Trans., vol. 46, p. 686, 1914.

[3] Idem, p. 664.

[4] The determination of arsenic and other solid constituents of smelter smoke, with a study of the effects of high stacks and large condensing flues: Am. Chem. Soc. Jour., vol. 19. p. 998, 1907.

Perhaps the greatest potential sources of selenium in this country, aside from blister copper, are the uranium and vanadium ores of the high plateaus of Colorado and Utah. Selenium was first noted in them by Dr. W. F. Hillebrand, who found what he considered to be an unidentified copper selenide in specimens collected by Gale in Routt County, Colo.[1] Later he found in specimens of metahewettite from Yellow Cat Wash, near Thompsons, Utah, what he believed to be native selenium.[2]

Selenium in some form occurs in nearly all the vanadium-bearing sandstones of Colorado and Utah. Its presence may be shown by heating a little of the material in a test tube. Nearly all specimens give a red selenium coating on the cold part of the tube when the material is heated to redness. It is driven off after the water. The quantity is always small, probably less than a pound of selenium to a ton of rock. The writer has not been able to isolate any mineral which he could be sure held the selenium. Selenium was noted 30 years ago in the silver deposits at Silver Reef (Leeds) in southwestern Utah.[3]

J. E. Spurr[4] has described the occurrence of selenium in the Tonopah, Nev., gold ores, where it is found, at least in part, as a silver selenide. The occurrence of considerable percentages of selenium in the gold bullion smelted from Tonopah and other Nevada ores is comparatively well known.

M. H. Joseph[5] reported selenide of silver at Republic, Wash., in 1899, but without details. Lindgren[6] noted selenium ores from Republic in 1909, and from later researches carried on by him and Chase Palmer the selenium appeared to occur as a selenide of gold,[7] Au_2Se_3. In a picked ore specimen 1.8 per cent of selenium was found. Selenium has been noted in small quantity in the Leadville sulphides.[8]

Selenium in gold ores and bullion has been recorded from a number of places. Selenium and tellurium were found in the mattes made from zinc box precipitates of the Camp Bird mine, Colorado,[9] but they are not known to have been found in the ores. The mattes examined carried 0.99 and 1.5 per cent selenium and 1.68 and 1.63 tellurium. Bullion from the Redjang Lebong mine, in southwestern Sumatra, carried 4.35 per cent of selenium,[10] but no tellurium. Selenium is also said to occur in the Hauraki gold fields of New Zealand.[11]

Selenium in minute quantity accompanies pyrites from many localities, and, should occasion demand, a considerable supply could undoubtedly be obtained from sulphuric acid towers and lead chambers, as at Gripsholm, Sweden. Selenium has been found in sulphuric

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[1] Gale, H. S., Carnotite and associated minerals in western Routt County, Colo.: U. S. Geol. Survey Bull. 340, p. 261, 1908.

[2] Hillebrand, W. F., Merwin, H. E., and Wright, F. E., Hewettite, metahewettite, and pascoite, hydrous calcium vanadates: Am. Philos. Soc. Proc., vol. 8, pp. 34–35, 1914.

[3] Newberry, J. S., The Silver Reef sandstones: Eng. and Min. Jour., vol. 31, p. 5, 1887. Analyses by J. B. Mackintosh are quoted which showed 0.23 per cent selenium.

[4] Spurr, J. E., Geology of the Tonopah mining district, Nev.: U. S. Geol. Survey Prof. Paper 42, p. 92, 1905.

[5] Joseph, M. H., The Republic mining camp, Washington: Eng. and Min. Jour., p. 636, 1899.

[6] Lindgren, Waldemar, Science, new ser., vol. 30, p. 972, 1909.

[7] Lindgren, Waldemar, and Bancroft, Howland, The Republic mining district: U. S. Geol. Survey Bull. 550, pp. 148–150, 1914.

[8] Guiterman, Franklin, On the use, nonuse, and waste of the mineral resources of Colorado: Colorado Sci. Soc. Proc., vol. 9, p. 449, 1910.

[9] Headden, W. P., Some mattes formed in melting zinc-box precipitates, their composition, and what it suggests: Colorado Sci. Soc. Proc., vol. 8, pp. 349–362, 1908.

[10] Truscott, S. J., The occurrence and mining of gold in the Dutch East Indies: Inst. Min. and Met. Trans., vol. 10, p. 54, 1901–1902.

[11] Allen, F. B., Tellurium in the ores of the Hauraki gold fields: Australasian Inst. Min. Eng. Trans., vol. 7, p. 98, 1901.

acid made from Colorado pyrite and has been reported as occurring in acids made from ores from other American localities. It would seem necessarily true that it would be found in the residues of acids made from ores from northern California and Butte, Mont.

Pyrite from Rio Tinto, Spain, which is burned in great quantities in this country in sulphuric acid plants, carries selenium in notable quantity, so that it collects with lead sulphate in the bottom of the lead chambers and in the towers. Several years ago one company made a ton or more of selenium from lead-chamber accumulations, but could find no market for the material, so that it made no further production.

The production of selenium in 1913 was 29,097 pounds, valued at $46,900, and in 1914 was 22,867 pounds, valued at $34,277.

USES.

Selenium has been most largely used in making glass, to which it gives a red color. It not only gives a distinct red color, such as that of the glass used for railroad signal lights, but overcomes or prevents a green color. Selenite of soda is used to give a bright red color to the enamels used on "enameled ware." The property possessed by metallic selenium of increasing resistance to an electric current with decrease of light has been the basis of many electrical inventions. Selenium is used in instruments for measuring the Roentgen rays used in therapeutic applications; in a form of Wheatstone bridge; in appliances intended to light and extinguish automatically the flame on gas buoys; in controlling street lights, electric signs, and moving pictures; in burglar alarms; and in controlling submarine boats.[1] It has been used in experiments in telephoning along a ray of light, and for transmitting sounds and pictures to a distance along a wire. Selenium cells for measuring the intensity of light have been constructed by a number of inventors. It has also been proposed to use selenium in sound detectors and in submarine telegraphy.

Selenium has been used as an embedding material for diatoms in microscopic work, and sodium selenite has been used in bacteriology for showing the reducing properties of bacteria.[2] A selenium compound has been advertised as a cancer cure, and amorphous selenium is used in the treatment of prurigo, pruritus, and eczema.

FIELD TESTS.

When selenium minerals are heated on charcoal before the blowpipe, they give off a peculiar fetid odor, very much like that of carbon disulphide, an odor spoken of in textbooks as that of "rotten horseradish"—an unknown sensation to most persons. If the selenium is sufficient in quantity it forms red fumes, a part of which is deposited on the charcoal as a deep red coating and a part is changed to selenium dioxide, SeO_2, and deposited as a silvery-white coating. If the blowpipe flame is turned upon the red coating it burns with a characteristic sky-blue flame. Heated in a closed tube selenide minerals form a red coating above the assay and may form a coating of white oxide. They emit the characteristic odor.

[1] English patents No. 3927, 1891, and No. 1866, 1899.

[2] Merck's Index, 1907.

TELLURIUM.[1]

By Frank L. Hess.

Tellurium is closely related chemically to sulphur and selenium, and though in appearance wholly metallic, it is not classed among the metals. It is brittle and crystalline and in color is very much like unoxidized zinc; and it is so soft that it can be scratched with a hard finger nail.

It is a rare element, though probably more plentiful than selenium, but unlike selenium, it is found native in easily distinguishable masses. It occurs in several mines in Boulder County, Colo., in thin veins, and is cited by Dana [2] as occurring in the John Jay mine, in the Central district, Colo., in "large masses." In the United States National Museum there is a fragment of a solid vein of tellurium half an inch thick, from the Good Hope mine, Vulcan, Colo. This fragment is coated on the sides with brown tellurite, TeO_2. Like arsenic and sulphur, tellurium, so far as known, is always an acid-forming element and in combination with metallic elements forms tellurides and tellurates.

Some of the tellurium minerals are found at a few places in considerable quantities. Thus sylvanite, $(Au,Ag)Te_2$, the gold-silver telluride, and calaverite, $AuTe_2$, a gold telluride containing some silver but less than sylvanite, are the principal gold-bearing minerals in the rich Cripple Creek district, Colo. Calaverite is in much greater quantity than sylvanite. Tellurides of gold are found in Boulder County, Colo., and at a few places in California, but Cripple Creek is the chief telluride-bearing district.

Tetradymite, Bi_2Te_3, bismuth telluride, is a fairly common mineral, though it is not known to occur in large quantity at any one place. It has been found at Radersburg, Mont.; at Dahlonega, Ga.; at the Tellurium mine, Fluvanna County, and at other places in Virginia; and at several places in Colorado and California. Some varieties of tetradymite contain sulphur that takes the place of part of the tellurium, and thus approach the composition $Bi_2Te_3 . Bi_2S_3$. Hessite, Ag_2Te, silver telluride, is a silver mineral that occurs in small quantity in some silver ores, but at no place in great quantity, considered as a source of tellurium.

Several other tellurium minerals are known, but those already named are probably the most common, though as the tellurium of commerce is all obtained as a by-product from copper ores in which

[1] Chemical symbol, Te; atomic weight, 127.5; specific gravity, 6.23; melting point, 451°±1C.
[2] System of Mineralogy, 6th ed., p. 11, 1909.

the form of the tellurium is unknown it can not be stated positively which mineral is the most plentiful.

The average of eight analyses of calaverite, which carries most of the gold at Cripple Creek, as quoted by Lindgren and Ransome,[1] is tellurium, 57.17; gold, 41.16; silver, 1.65. The ratio of tellurium to gold in calaverite is therefore about 7 to 5, and as $600,000 in gold weighs about a short ton, practically 20 tons of gold ($11,966,116) were produced at Cripple Creek in 1914, the ore of which must have contained about 28 tons of tellurium, none of which was saved. Since the beginning of the camp, in 1891, Cripple Creek has produced $258,756,653 in gold,[2] or about 431 tons, and this must have been accompanied by about 600 tons of tellurium, if the ratios stated hold good.

The electrolytic refining of copper, however, can furnish much greater quantities of tellurium than the ores of gold.

In the figures furnished by Eilers [3] and Antisell,[4] already quoted, recoverable tellurium is reported to occur in blister copper in the quantities shown below:

Quantity of tellurium in 100 tons of blister copper.

	Pounds.
Garfield, Utah	5.54
Omaha, Nebr	67.1
Mountain, Cal	3.33
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Eilers reports no recovery of tellurium from blister copper from the smelters at Steptoe, Nev.; Tacoma, Wash.; Aguascalientes, Mexico; Cerro de Pasco, Peru; and Mount Lyell, Tasmania, so it is understood that none was found in copper from these smelters. Tellurium, like arsenic, bismuth, and selenium, passes through the smelter flues in large quantities and is dissipated by the winds.

The form in which tellurium occurs in the original ores is unknown, but it is possibly in tetradymite—Bi_2Te_3, a telluride of bismuth—as bismuth is reported in all the blister coppers, and tetradymite and the closely allied species joseite, which contains a little sulphur and selenium, are widely distributed.

Tellurium is found in pyrite from Rio Tinto, Spain, which is largely burned in this country for making sulphuric acid, and the tellurium, like the selenium, can probably be collected from the chambers and towers of the acid plants. Bismuth occurs in these ores also, possibly as a telluride.

Tellurium doubtless occurs in many sulphide deposits that are connected with igneous intrusions, but in quantities so small that it can not be detected except by very careful search. As tellurium is of almost no present commercial value, little attention is paid to it. Some tellurium has been isolated from anode muds in the electrolytic

[1] The geology and gold deposits of the Cripple Creek district, Colo.: U. S. Geol. Survey Prof. Paper 54, p. 117, 1906.

[2] Figures compiled by Charles W. Henderson. See p. 265 of this volume.

[3] Eilers, A., Notes on the occurrence of some of the rarer metals in blister copper: Am. Inst. Min. Eng. Trans., vol. 47, p. 217, 1914.

[4] Letter of F. L. Antisell. Average figures for 1914.

refining of copper, and one company shipped several hundred pounds abroad in 1913, but so little use has been found for it that practically none is known to have been saved during 1914.

Efforts have been made to use tellurium in bearing metals, but apparently without success. It has been used in coloring glass, to which it gives a peculiar reddish tint, and Samuel Wein has patented an alloy of aluminum, zinc, and tellurium. He claims that a mixture of 50 to 85 parts of aluminum, 49 down to 14 parts of zinc, and one-fourth to 1 part of tellurium makes an alloy that is superior to aluminum in tensile and torsional strength.

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DEPARTMENT OF THE INTERIOR

FRANKLIN K. LANE, SECRETARY

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

MINERAL PRODUCTS OF THE UNITED STATES

Calendar Years 1905 to 1914

PRODUCT.	1905.		1906.		1907.		1908.		1909.		1910.		1911.		1912.		1913.		1914.		PRODUCT.
	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	
METALLIC.																					
Aluminum (consumption)..pounds..	11,347,000	$3,246,300	14,910,000	$4,262,286	17,211,000	$4,926,948	11,152,000	$2,434,600	34,210,000	$6,575,000	47,734,000	$8,955,700	46,125,000	$8,084,000	65,607,000	$11,907,000	72,379,000	$13,845,000	79,129,000	$14,522,700	Aluminum.
Antimonial lead (*a*).....short tons (2,000 pounds)..	10,995	1,217,571	10,546	1,720,952	9,910	1,322,985	13,629	1,264,771	12,896	1,231,019	14,069	1,338,090	14,078	1,380,556	13,552	1,311,348	16,665	1,591,854	16,667	1,572,167	Antimonial lead.
Antimony (*b*).....do....	3,240	*b* 705,787	1,766	*b* 602,949	1,912	*b* 586,186	2,246	*b* 359,360	2,360	*b* 368,160	2,229	*b* 367,337	2,254	*b* 386,786	1,949	*b* 332,889	2,508	*b* 429,363	2,705	*b* 576,501	Antimony.
Bauxite.....long tons (2,240 pounds)..	48,129	240,292	75,332	368,311	97,776	480,330	52,167	263,968	129,101	679,447	148,932	716,258	155,618	750,649	159,865	768,932	210,241	997,698	219,318	1,069,194	Bauxite.
Chromic iron ore.....do....	22	375	107	1,800	290	5,640	359	7,230	598	8,300	205	2,729	120	1,629	201	2,753	255	2,854	591	8,715	Chromic iron ore.
Copper (*c*), value at New York City.....pounds..	888,784,267	137,761,561	917,805,682	177,595,888	868,996,491	173,799,300	942,570,721	124,419,335	1,092,951,624	142,083,711	1,080,159,509	137,180,257	1,097,232,749	137,154,092	1,243,268,720	205,139,338	1,224,484,098	189,795,035	1,150,137,192	152,968,246	Copper.
Ferroalloys (*d*).....long tons..	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)	253,375	8,377,832	328,685	12,223,776	296,207	13,015,362	255,524	9,350,245	Ferroalloys.
Gold (*e*).....troy ounces..	4,265,742	88,180,700	4,565,333	94,373,800	4,374,827	90,435,700	4,574,340	94,560,000	4,821,701	99,673,400	4,657,018	96,269,100	4,687,053	96,890,000	4,520,717	93,451,500	4,299,784	88,884,400	4,572,976	94,531,800	Gold.
Iron.. Ore (*f*).....long tons..	42,526,133	*f* 75,165,604	47,749,728	*f* 100,597,106	51,720,619	*f* 131,996,147	35,983,336	*f* 81,845,904	51,155,437	*f* 109,964,903	56,889,734	*f* 140,735,607	41,092,447	*f* 86,716,575	57,017,614	*f* 107,050,153	59,643,098	*f* 130,905,558	39,714,280	*f* 71,905,079	Iron ore.
Iron.. Pig (*d*).....do....	*d* 22,992,380	*d* 382,450,000	*d* 25,307,191	*d* 505,700,000	*d* 25,781,361	*d* 529,958,000	*d* 15,936,018	*d* 254,321,000	*d* 25,795,471	*d* 419,175,000	*d* 26,674,123	*d* 412,162,486	23,257,288	327,334,624	30,180,969	420,563,388	30,388,935	458,342,345	22,263,263	298,777,429	Iron, pig.
Lead (refined) (*c*), value at New York City.....short tons..	307,514	28,906,316	336,200	38,326,800	352,381	37,352,386	311,666	26,179,944	352,839	30,344,154	375,402	33,035,376	391,995	35,279,550	392,517	35,326,530	411,878	36,245,264	512,794	39,997,932	Lead.
Manganese ore.....long tons..	4,118	36,214	6,921	88,132	5,604	63,369	6,144	62,779	1,544	19,675	2,258	22,892	2,457	24,586	1,664	15,723	4,048	40,480	2,635	27,377	Manganese ore.
Manganiferous ore (*g*).....do....	130,896	387,438	41,300	122,400	103,844	259,473	55,894	133,104	68,654	215,925	61,101	186,765	44,437	114,918	51,517	19,942	59,403	25,124	98,265	218,497	Manganiferous ore.
Nickel (*h*), value at New York City.....pounds..	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	890,000	127,000	(*i*)	(*i*)	481,565	79,393	845,334	313,000	Nickel.
Platinum and allied metals, value at New York City.....troy ounces..	318	5,320	1,439	45,189	357	10,589	750	14,250	638	15,950	773	25,277	940	40,890	1,005	45,778	1,034	46,530	6,324	280,885	Platinum and allied metals
Quicksilver, value at San Francisco.....flasks (75 pounds net)..	30,534	1,105,941	26,083	1,030,279	21,554	853,538	19,752	872,446	21,075	957,859	20,601	958,153	21,256	977,989	25,064	1,053,941	20,213	813,171	16,548	811,680	Quicksilver.
Silver.....troy ounces..	56,101,600	34,222,000	56,517,900	38,256,400	56,514,700	37,299,700	52,440,800	28,050,600	54,721,500	28,455,200	57,137,900	30,854,500	60,399,400	32,615,700	63,766,800	39,197,500	66,801,500	40,348,100	72,455,100	40,067,700	Silver.
Tin (metallic equivalent).....pounds..				35,600		33,285				17,499		23,447		56,635		124,800		46,699	208,000	66,560	Tin.
Titanium ore (rutile).....short tons..	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)				10,000	566	44,480			275	27,500	305	49,000	94	11,280	Titanium ore (rutile).
Tungsten ore (60 per cent concentrates since 1906).....short tons..	803	268,676	928	348,867	1,640	890,048	671	229,955	1,619	614,370	1,821	832,992	1,139	407,985	1,330	502,158	1,537	672,118	990	435,000	Tungsten ore.
Uranium and vanadium minerals.....do....	4	375	(*i*)	(*i*)	(*i*)	(*i*)			(*i*)	(*i*)	(*i*)	(*i*)		305,500	(*i*)	(*i*)	(*j*)	*j* 609,361	(*j*)	*j* 941,300	Uranium and vanadium minerals.
Zinc (*c*), value at St. Louis.....do....	203,849	24,054,182	199,694	24,362,668	223,745	26,401,910	190,749	17,930,406	230,225	24,864,300	252,479	27,267,732	271,621	30,964,794	323,907	44,699,166	337,252	37,772,224	343,418	35,028,836	Zinc.
Total value of metallic products.....		702,083,261		886,639,372		904,093,201		550,744,388		754,940,809		749,876,234		680,888,929		866,381,073		883,222,012		691,000,343	Metallic.
NONMETALLIC.																					
Arsenious oxide.....short tons..	754	35,210	737	63,460	1,751	163,000	(*i*)	(*i*)	1,214	52,946	1,497	52,305	3,132	73,408	3,141	190,757	2,513	159,236	4,670	313,147	Arsenious oxide.
Asbestos.....do....	3,109	42,975	1,695	28,565	653	11,899	936	19,624	3,085	62,603	3,693	68,357	7,604	119,935	4,403	87,959	1,100	11,000	1,247	18,965	Asbestos.
Asphalt.....do....	115,267	758,153	138,059	1,290,340	223,861	2,826,489	198,382	2,057,881	228,655	2,138,273	260,080	3,080,067	364,266	3,991,109	449,510	4,620,731	529,190	5,282,370	438,271	3,647,592	Asphalt.
Barytes (crude).....do....	48,235	148,803	50,231	160,367	89,621	291,777	38,527	120,442	61,945	209,737	42,975	121,746	38,445	122,792	37,478	153,313	45,298	156,275	51,547	153,715	Barytes.
Borax (crude).....do....	46,334	1,019,154	58,173	1,182,410	52,850	1,121,520	25,000	975,000	41,434	1,534,365	42,357	1,201,842	53,330	1,569,151	42,315	1,127,813	58,051	1,491,530	62,400	1,464,400	Borax.
Bromine.....pounds..	1,192,758	178,914	1,283,250	165,204	1,379,496	195,281	760,023	73,783	569,725	57,600	245,437	31,684	651,541	110,902	647,200	145,805	572,400	115,436	576,991	203,094	Bromine.
Calcium chloride.....short tons..									12,853	63,198	10,971	74,713	14,606	91,215	18,550	117,272	19,611	130,030	19,403	121,766	Calcium chloride.
Cement.....barrels (380 pounds net)..	40,102,308	35,931,533	51,000,445	55,302,277	52,230,342	55,903,851	52,910,925	44,477,656	66,689,715	53,610,563	77,785,141	68,752,092	79,547,958	66,705,136	85,925,651	69,554,385	89,541,348	89,550,527	87,257,552	80,533,203	Cement.
Clay.. Products.....		149,697,188		161,032,722		158,942,369		133,197,762		166,321,213		170,115,974		162,236,181		172,811,275		181,289,132		164,986,983	Clay products.
Clay.. Raw (*f*).....short tons..	1,806,133	*f* 2,768,006	2,027,452	*f* 3,245,256	2,183,679	*f* 3,448,548	1,723,901	*f* 2,599,986	2,159,647	*f* 3,449,707	2,389,229	*f* 3,625,485	2,182,698	*f* 3,480,763	2,530,265	*f* 3,946,020	2,647,989	*f* 4,180,459	2,209,860	*f* 3,756,568	Clay, raw.
Coal.. Bituminous (*b*).....do....	315,062,785	334,658,294	342,874,867	381,162,115	394,759,112	451,214,842	332,573,944	374,135,268	379,744,257	405,486,777	417,111,142	469,281,719	405,907,059	451,375,819	450,104,982	517,983,445	478,435,297	565,234,952	422,703,970	493,309,244	Bituminous coal.
Coal.. Pennsylvania anthracite.....long tons..	69,339,152	141,879,000	63,645,010	131,917,694	76,432,421	163,584,056	74,347,102	158,178,849	72,384,249	149,181,587	75,433,246	160,275,302	80,771,488	175,189,392	75,322,855	177,622,626	81,718,680	195,181,127	81,090,631	188,181,399	Pennsylvania anthracite.
Cobalt oxide.....pounds..	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)	(*i*)											Cobalt oxide.
Coke (*f*).....short tons..	32,231,129	*f* 72,478,196	36,401,217	*f* 91,608,034	40,779,564	*f* 111,539,126	26,033,518	*f* 62,483,983	39,315,065	*f* 89,965,483	41,708,810	*f* 99,742,701	35,551,489	*f* 84,130,849	43,983,599	*f* 111,805,113	46,299,530	*f* 128,922,273	34,555,914	*f* 88,334,217	Coke
Diatomaceous (infusorial) earth and tripoli..do....	10,977	64,637	8,099	72,108		104,406		97,442		122,348		130,006		147,462		125,446		285,821		252,327	Diatomaceous (infusorial) earth and tripoli.
Emery (also corundum in 1905 and 1906)..do....	2,126	61,464	1,160	44,310	1,069	12,294	669	8,745	1,580	18,185	1,028	15,077	659	6,778	992	6,652	957	4,785	485	2,425	Emery and corundum.
Feldspar.....do....	35,419	226,157	72,656	401,531	91,799	558,944	70,474	428,553	76,539	424,602	81,102	502,452	92,700	579,008	86,572	520,562	120,955	776,551	135,419	629,873	Feldspar.
Fluorspar.....do....	57,385	362,488	40,796	244,025	49,486	287,342	38,785	225,998	50,742	291,747	69,427	430,196	87,048	611,447	116,545	769,163	115,580	736,286	95,116	570,041	Fluorspar.
Fuller's earth.....do....	25,178	214,497	32,040	265,400	32,851	291,773	29,714	278,367	33,486	301,604	32,822	293,709	40,697	383,124	32,715	305,522	38,594	369,750	40,981	403,646	Fuller's earth.
Garnet for abrasive purposes.....do....	5,050	148,095	4,650	157,000	7,058	211,686	1,996	64,620	2,972	102,315	3,814	113,574	4,076	121,748	4,947	163,237	5,308	183,422	4,231	145,510	Garnet (abrasive).
Gems and precious stones.....		326,350		208,000		471,300		415,063		534,280		295,797		343,692		319,722		319,454		124,651	Gems and precious stones.
Graphite. amorphous.....short tons..	21,953	80,639	16,853	102,175	26,803	125,821	1,443	75,250	5,096	32,238	1,407	39,710	1,223	32,415	2,063	32,894	2,243	39,428	1,725	38,750	Graphite.
Graphite. crystalline.....pounds..	6,036,567	237,572	5,887,982	238,064	4,947,840	171,149	2,288,000	132,840	6,294,400	313,271	5,590,592	295,733	4,790,000	256,050	3,543,771	187,689	5,064,727	254,328	5,220,539	285,368	Graphite.
Grindstones and pulpstones.....		777,606		744,894		896,022		536,095		804,051		796,294		907,316		916,339		855,627		689,344	Grindstones and pulpstones.
Gypsum.....short tons..	1,043,209	3,029,227	1,540,585	3,837,975	1,751,748	4,942,264	1,721,829	4,075,824	2,252,785	5,906,738	2,379,057	6,523,029	2,323,970	6,462,035	2,500,757	6,583,908	2,599,508	6,774,822	2,478,465	6,895,989	Gypsum.

Cobalt oxide	pounds	(i)		(i)		(i)		(i)		(i)		(i)																		Cobalt oxide.
Coke (f)	short tons	32,231,129	f 72,476,196	36,401,217	f 91,608,034	40,779,564	f 111,539,126	26,033,518	f 62,483,983	39,315,065	f 89,965,483	41,708,810	f 99,742,701	35,551,489	f 84,130,849	43,983,599	f 111,805,113	46,299,530	f 128,922,273	34,555,914	f 88,334,217	Coke.
Diatomaceous (infusorial) earth and tripoli	do	10,977	64,637	8,099	72,108		104,406		97,442		122,348		130,006		147,462		125,446		285,821		252,327	Diatomaceous (infusorial) earth and tripoli.
Emery (also corundum in 1905 and 1906)	do	2,126	61,464	1,160	44,310	1,069	12,294	669	8,745	1,580	18,185	1,028	15,077	659	6,778	992	6,652	957	4,785	485	2,425	Emery and corundum.
Feldspar	do	35,419	226,157	72,656	401,531	91,799	558,944	70,474	428,553	76,539	424,602	81,102	502,452	92,700	579,008	86,572	520,562	120,955	776,551	135,419	629,873	Feldspar.
Fluorspar	do	57,385	382,488	40,786	244,025	49,486	287,342	38,785	225,998	50,742	291,747	69,427	430,196	87,048	611,447	116,545	769,163	115,580	736,286	95,116	570,041	Fluorspar.
Fuller's earth	do	25,178	214,497	32,040	265,400	32,851	291,773	29,714	278,367	33,486	301,604	32,822	293,709	40,697	383,124	32,715	305,522	38,594	369,750	40,981	403,646	Fuller's earth.
Garnet for abrasive purposes	do	5,050	148,095	4,650	157,000	7,058	211,686	1,996	64,620	2,972	102,315	3,814	113,574	4,076	121,748	4,947	163,237	5,308	183,422	4,231	145,510	Garnet (abrasive).
Gems and precious stones			326,350		208,000		471,300		415,063		534,280		295,797		343,692		319,722		319,454		124,651	Gems and precious stones.
Graphite: amorphous	short tons	21,953	80,639	16,853	102,175	26,803	125,821	1,443	75,250	5,096	32,238	1,407	39,710	1,223	32,415	2,063	32,894	2,243	39,428	1,725	38,750	Graphite.
Graphite: crystalline	pounds	6,036,567	237,572	5,887,982	238,064	4,947,840	171,149	2,288,000	132,840	6,294,400	313,271	5,590,592	295,733	4,790,000	256,050	3,543,771	187,689	5,064,727	254,328	5,220,539	285,368	Graphite.
Grindstones and pulpstones			777,606		744,894		896,022		536,095		804,051		796,294		907,316		916,339		855,627		689,344	Grindstones and pulpstones.
Gypsum	short tons	1,043,202	3,029,227	1,540,585	3,837,975	1,751,748	4,942,264	1,721,829	4,075,824	2,252,785	5,906,738	2,379,057	6,523,029	2,323,970	6,462,035	2,500,757	6,563,908	2,599,508	6,774,822	2,476,465	6,895,989	Gypsum.
Lime	do	2,984,100	10,941,680	3,198,087	12,480,653	3,092,524	12,656,705	2,766,873	11,091,186	3,484,974	13,846,072	3,505,954	14,088,039	3,392,915	13,689,054	3,529,462	13,970,114	3,595,390	14,648,362	3,380,928	13,247,676	Lime.
Lithium minerals	do	79	1,412	383	7,411	530	11,000	203	1,550	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	Lithium minerals.
Magnesite (crude)	do	3,933	15,221	7,805	23,415	7,561	22,683	6,587	19,761	9,465	37,860	12,443	74,658	9,375	75,000	10,512	84,096	9,632	77,056	11,293	124,223	Magnesite.
Marls	do	38,026	16,494	19,104	7,341	14,091	8,429	8,469	4,330	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	Marls.
Mica: scrap	do	1,126	17,856	1,489	22,742	3,025	42,800	2,417	33,904	4,090	46,047	4,065	53,265	3,512	45,550	3,226	49,073	5,322	82,543	3,730	51,416	Mica.
Mica: sheet	pounds	924,875	160,732	1,423,100	252,248	1,060,182	349,311	972,964	234,021	1,809,582	234,482	2,476,190	283,832	1,887,201	310,254	845,483	282,823	1,700,677	353,517	556,933	278,540	Mica.
Millstones			37,974		48,590		31,741		31,420		35,393		28,217		40,069		71,414		56,163		43,316	Millstones.
Mineral paints: natural pigments (l)	short tons	49,765	490,015	52,959	526,076	52,139	536,263	50,403	493,900	60,220	567,028	68,623	527,795	62,739	498,821	74,657	561,693	70,595	512,410	66,766	473,036	Mineral paints.
Mineral paints: zinc-lead pigments (l)	do	82,359	6,727,355	90,792	7,639,107	95,211	8,939,332	75,133	6,946,283	87,525	7,963,332	75,162	6,852,804	80,611	7,343,762	106,497	9,507,895	97,573	9,020,896	106,791	9,978,710	Mineral paints.
Mineral waters	gallons sold	46,544,361	6,491,251	48,108,580	8,028,387	52,060,520	7,331,503	55,868,820	6,712,680	64,674,486	6,894,134	62,030,125	6,357,590	63,788,552	6,837,888	62,281,201	6,615,671	57,867,399	5,631,391	54,388,466	4,892,328	Mineral waters.
Natural gas			41,562,855		46,873,932		54,222,399		54,640,374		63,206,941		70,756,158		74,621,534		84,563,957		87,846,677		94,115,524	Natural gas.
Oilstones, etc.			244,546		268,070		264,188		217,284		214,019		228,694		214,991		232,218		207,352		167,648	Oilstones, etc.
Peat									133,000		127,042		140,209		272,114		228,572		197,200		309,692	Peat.
Petroleum	barrels (42 gallons)	134,717,580	84,157,399	126,493,936	92,444,735	166,095,335	120,106,749	178,527,355	129,079,184	183,170,874	128,328,487	209,557,248	127,899,688	220,449,391	134,044,752	222,935,044	164,213,247	248,446,230	237,121,388	265,762,535	214,125,215	Petroleum.
Phosphate rock	long tons	1,947,190	6,763,403	2,080,957	8,579,437	2,265,343	10,653,558	2,386,138	11,399,124	2,338,264	10,796,456	2,654,988	10,917,000	3,053,279	11,900,693	2,973,332	11,675,774	3,111,221	11,796,231	2,734,043	9,608,041	Phosphate rock.
Pumice	short tons	1,832	5,540	12,200	16,750	8,112	33,818	10,569	39,287	15,103	33,439	23,271	94,943	21,689	88,399	27,146	86,687	24,563	55,408	27,591	59,172	Pumice.
Pyrite	long tons	253,000	938,492	261,422	931,305	247,387	794,949	222,598	857,113	247,070	1,028,157	241,612	977,978	301,458	1,164,871	350,928	1,334,259	341,338	1,286,084	336,662	1,283,346	Pyrite.
Salt	barrels (280 pounds, net)	25,966,122	6,095,922	28,172,380	6,658,350	29,704,128	7,608,323	28,822,062	7,553,632	30,107,646	8,343,831	30,305,656	7,900,344	31,183,968	8,345,692	33,324,808	9,402,772	34,399,298	10,123,139	34,804,683	10,271,358	Salt.
Sand: glass	short tons	1,060,334	1,107,730	1,089,430	1,208,788	1,187,296	1,250,067	1,093,553	1,134,599	1,104,451	1,163,375	1,461,089	1,516,711	1,538,666	1,543,733	1,465,386	1,430,471	1,791,800	1,895,991	1,619,649	1,568,030	Sand and gravel.
Sand: molding, building, etc., and gravel	do	22,144,633	10,115,915	31,842,572	11,489,420	40,664,622	13,242,002	36,122,491	12,135,433	58,461,100	17,173,615	67,949,347	19,520,919	65,308,293	19,614,850	66,889,175	21,682,737	77,764,049	22,321,517	77,662,086	22,278,969	Sand and gravel.
Sand-lime brick			972,064		1,170,005		1,225,769		1,029,699		1,150,580		1,169,153		897,664		1,200,223		1,238,325		1,058,512	Sand-lime brick.
Silica (quartz)	short tons	70,184	192,227	90,779	364,683	33,192	223,801	47,316	190,157	135,469	249,466	63,577	193,757	87,943	155,122	97,874	191,685	97,902	201,488	153,401	360,502	Silica (quartz).
Slate			5,496,207		5,668,346		6,019,220		6,316,817		5,441,418		6,236,759		5,728,019		6,043,318		6,175,476		5,706,787	Slate.
Stone			63,798,748		66,378,794		71,105,805		65,712,499		71,345,199		76,520,584		77,108,567		78,193,220		83,732,995		77,412,292	Stone.
Sulphur	long tons	181,677	3,706,560	294,153	5,096,678	293,106	5,142,850	369,444	6,668,215	239,312	4,432,066	255,534	4,605,112	265,664	4,787,049	303,472	5,256,422	311,590	5,479,849	327,634	5,954,236	Sulphur.
Sulphuric acid (60° Baumé) from copper and zinc smelters	short tons													438,300	2,733,696	614,073	4,240,941	632,237	4,346,272	760,638	5,190,293	Sulphuric acid from smelters.
Talc and soapstone (exclusive of fibrous talc)	do	40,134	637,062	58,972	874,356	72,010	905,047	46,615	703,832	81,802	862,002	79,006	864,213	81,521	1,032,732	93,413	1,050,693	94,128	1,119,597	86,221	1,043,801	Talc and soapstone.
Talc, fibrous	do	56,500	445,000	61,672	557,200	67,800	626,000	70,739	697,390	48,536	359,957	71,710	728,180	62,030	613,286	66,867	656,270	81,705	788,500	86,075	821,286	Talc and soapstone.
Thorium minerals (monazite), and zircon	pounds	1,352,418	163,908	847,275	152,560	548,152	65,800	422,646	50,718	543,931	65,282	99,301	12,006	3,208	802							Thorium minerals (monazite), and zircon.
Total value of nonmetallic products			921,181,524		1,016,390,015		1,165,748,197		1,043,702,454		1,131,515,921		1,241,039,986		1,245,145,079		1,377,152,760		1,555,517,716		1,423,395,681	Nonmetallic.
Total value of metallic products			702,083,261		886,639,372		904,093,201		550,744,388		754,940,809		749,876,234		680,888,929		866,381,073		883,222,012		691,000,343	Metallic.
UNSPECIFIED.[m]																						
Metallic and nonmetallic (estimate)			400,000		200,000		100,000		250,000		300,000		300,000		250,000		500,000		420,000		m 550,000	Unspecified.
Grand total			1,623,664,785		1,903,229,387		2,069,941,398		1,594,696,842		1,886,756,730		1,991,216,220		1,926,284,008		2,244,033,833		2,439,159,728		2,114,946,024	Total.

[a] From both domestic and foreign ores.

[b] From all sources. Values excluded from metallic totals as the values of the antimony contained in antimonial lead are included in the antimonial lead values, and the remainder under "Unspecified."

[c] Product from domestic ores only.

[d] Ferro-alloys included in pig iron prior to 1911. Statistics of output prior to 1910 were furnished by the American Iron and Steel Association. Ferro-alloys include ferromanganese, spiegeleisen, ferrosilicon, ferrophosphorus, ferromolybdenum, ferrotitanium, ferrotungsten, and ferrovanadium.

[e] In 1905, value, $20.671834 an ounce; since 1905, $20.67183465323 an ounce.

[f] Value not included in total value.

[g] Exclusive of those ores from Lake Superior district running so low in manganese as to be classed with iron ore.

[h] By-product in electrolytic copper refining.

[i] Value included under "Unspecified."

[j] 1913: consists of 2,269 tons of uranium ore (carnotite); 10.5 grams of radium, not isolated; and 432 tons of vanadium in roscoelite and carnotite ores with an arbitrarily assigned value. 1914: 4,294 tons of uranium ore (carnotite), valued at $441,300 including the value of 22.3 grams of radium, not isolated; and 452 tons of vanadium in roscoelite and carnotite ores with an arbitrarily assigned value of $500,000.

[k] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.

[l] Natural pigments: ocher, umber, sienna, metallic paint, mortar colors, and ground slate and shale. Zinc-lead pigments: sublimed blue lead, sublimed white lead, leaded zinc oxide, zinc oxide, and zinc lead.

[m] Includes in 1914 bismuth, cadmium, ilmenite, lithium, marls, molybdenum, selenium, and an estimate of the value of miscellaneous mineral products not collected annually by the Survey.

TOTAL VALUE OF THE MINERAL PRODUCTS SINCE 1880.

[IN DOLLARS.]

	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.
Metallic	185,649,163	187,549,908	214,061,009	196,547,259	179,230,899	172,491,087	203,249,225	236,598,254	237,574,422	247,768,701	292,649,877	282,617,183	281,514,539	219,436,649	185,804,594	245,874,431	251,445,519	265,209,975	305,482,183	487,831,631	511,632,891	480,006,859	599,916,009	583,433,948	502,149,624	702,083,261	886,639,372	904,093,201	550,744,388	754,940,809	749,876,234	680,888,929	866,381,073	883,222,012	691,000,343
Nonmetallic	178,279,135	206,783,144	231,340,150	243,812,214	221,879,500	241,312,093	230,088,769	270,989,420	286,150,114	282,623,812	312,826,503	321,767,846	340,028,842	323,257,318	362,570,173	393,897,087	388,098,702	380,782,607	417,790,671	525,524,074	594,398,501	660,850,112	722,027,126	905,242,380	859,543,144	921,181,524	1,016,390,015	1,165,748,197	1,043,702,454	1,131,515,921	1,241,039,986	1,245,145,079	1,377,152,760	1,555,517,716	1,423,395,681
Unspecified	6,000,000	6,500,000	6,500,000	6,500,000	5,000,000	5,000,000	800,000	800,000	900,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	400,000	400,000	200,000	100,000	250,000	300,000	300,000	250,000	500,000	420,000	550,000
Total	364,928,298	400,833,052	451,901,159	446,859,473	406,110,405	418,803,180	434,137,994	508,387,674	524,624,536	531,392,513	606,476,380	605,385,029	622,543,381	543,693,967	549,374,767	640,771,528	640,544,221	646,992,582	724,272,854	1,014,355,705	1,107,031,392	1,141,856,971	1,322,943,135	1,489,676,328	1,362,092,768	1,623,664,785	1,903,229,387	2,069,941,398	1,594,696,842	1,886,756,730	1,991,216,220	1,926,284,008	2,244,033,833	2,439,159,728	2,114,946,024

Washington, D. C., November, 1915.

Compiled by MARTHA B. CLARK under direction of

H. D. McCASKEY,

Geologist in Charge of Mineral Resources.

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